The Macro Impact of Firm Earnings Targets

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September 16, 2014

(Job Market Paper: Preliminary & Incomplete)

Abstract

When managers make long-term investment decisions, they face a tradeoff between meeting forecasts or targets for short-term accounting profits today and the future prospects of the firm. Empirically, firms that just meet analyst forecasts of earnings reduce the growth of their long-term investments, and CEOs that just fail to meet earnings targets face lower compensation as well as higher turnover rates. In a structurally estimated quantitative general equilibrium endogenous growth model with heterogeneous firms, manager R&D and accounting manipulation choices, as well as endogenous market forecasts of earnings, dynamic costs of earnings pressure arise from excessive dependence of R&D on short-term profitability shocks. Less efficient R&D investments imply lower firm value, aggregate growth, and welfare. However, explicit consideration of manager shirking and empire-building agency conflicts within the model of manager decision-making reveals that even though earnings targets are damaging to long-term investment efficiency, short-term benchmarks can in fact improve firm value on average as well as increase social welfare, lending insight into the potential source of short-term pressures.

Keywords: Short Termism, Earnings Manipulation, Heterogeneous Agents, Endogenous Growth, Agency Conflicts, Shirking, Empire Building

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1 Introduction

Firms face a constant tradeoff between profits now and investment in the long term. The benefits from investments in research and development (R&D) or other intangibles may either fail to materialize or appear only much later. Yet the costs of these long-term investments must be immediately subtracted or expensed from profits according to the Generally Accepted Accounting Principles (GAAP) governing public firms in the US.\footnote{See Financial Accounting Standards Board (FASB) rule 730-10-25-1 for the explicit statement of the rule in 2014 US GAAP. By contrast, EU accounting guidelines do allow for discretionary depreciation or amortization of R&D development costs (PWC, 2013).} If failure to deliver short-term results has adverse consequences, firms or managers may therefore be willing to sacrifice some long-term value for the purposes of delivering higher performance now.\footnote{It is important to note that short termism is not an exclusively American concern, nor a particularly recent one. See (Mayer, 2012; Markoff, 1990; Michie, 2001) for British and historical perspectives.} Economic theory for decades has modeled overall growth and changes in aggregate productivity as the result of long-term investment at the microeconomic level, so a heavy dependence of such investment on short-term pressures can be crucial for understanding the process of economic growth in the macroeconomy.\footnote{See, for example, foundational work by (Romer, 1990; Aghion and Howitt, 1992; Grossman and Helpman, 1991). Also, note that a recent strand of papers models endogenous growth as the product of a idea flows from imitation or learning (Perla and Tonetti, 2014; Lucas and Moll, 2011; Alvarez et al., 2008; Sampson, 2014). Since exploiting idea flows remains costly for firms, the tradeoff between long-term growth and short-term performance remains.} Furthermore, factors impacting long-term growth disproportionately affect the economy in quantitative terms because of their permanent and compounding effects. Motivated by such considerations, this paper takes several concrete steps towards empirically documenting and structurally quantifying the costs of short termism, as embedded in pressure to meet earnings forecasts, on innovative investments, long-term growth, and welfare.

Some further initial context is helpful. Research analysts at stock brokerages routinely forecast the earnings of public companies. Firms publicly release statements of earnings, an accounting measure of profitability also known as net income or simply profits, at the end of each fiscal quarter and year. The financial press as well as equity market participants follow these releases closely during earnings season. Firms and managers face apparent pressure to deliver reported profits above the consensus (mean or median) analyst forecast. Figure I displays the distribution of annual or year-end earnings forecast errors, scaled by firm assets and equal to the difference between realized earnings and forecast levels for a large panel
of US public firms from 1982-2010. A disproportionate number of firm-years report zero or just positive earnings forecast errors, i.e. display profits that just “meet or beat” analyst forecasts, while the mass of forecast errors is hollowed out just below zero.\(^4^5\)

The pressures and incentives surrounding innovation at large public firms should impact our broad understanding of innovation in the macroeconomy. Such firms undertake well over half (56%) of all R&D expenditures in the United States, yet recent studies by Bernstein (2012) or Aghion et al. (2013) suggest that the quality or quantity of innovation at publicly traded firms can either be degraded relative to their private counterparts or hinge crucially upon factors such as institutional ownership with long horizons.\(^6^\) Theoretical contributions by Acemoglu and Cao (2010) and Acemoglu et al. (2013) underline both the importance of innovation by large incumbent firms and their potential for misuse of skilled resources in innovation. A long history of research in accounting into apparent “real earnings manipulation” by public firms also suggests that R&D investments systematically and discontinuously change around earnings benchmarks or targets including analyst forecasts of profits.\(^7^\) More broadly, a literature on either investments in technology or upgrading notes that quirks in budgeting deadlines or even agency frictions within firms can constrain the ability of organizations to invest in improved productivity.\(^8^\)

The paper first establishes two empirical facts using a merged database of analyst forecasts and firm accounting data. Firms that just meet or beat analyst forecasts in a particular year exhibit discontinuously lower R&D and broader intangibles investment growth, with precisely estimated drops of around 25% for each measure relative to firms that just fail to meet earnings forecasts. Such discontinuities, detected using flexible nonparametric regression discontinuity estimators, are consistent with systematic changes or manipulation

\(^{4}\)Marinovic et al. (2012) and Hong and Kacperczyk (2010) provide wide overviews of the institutional environment surrounding analyst earnings forecasts. Burgstahler and Chuk (2013) emphasize that the discontinuity or kink or bunching in Figure I is pervasive. The bootstrapped Chetty et al. (2011) bunching test statistic indicates around 70% excess mass near zero, strongly rejecting continuity, and the McCrary (2008) sorting test also strongly rejects continuity of the distribution at the zero forecast error level.

\(^{5}\)See Garicano et al. (2013), Gourio and Roys (2012), Chetty et al. (2011), Daly et al. (2012), and Allen and Dechow (2013), respectively for evidence of similar bunching in French firm sizes around regulatory thresholds, Danish income around tax kinks, nominal wage changes around zero, and even marathon finish times around focal points.

\(^{6}\)This statistic reflects the aggregation of R&D expenditures in my baseline sample from Compustat (xrd) compared to NSF aggregate research expenditures in 2007 from the Survey of Industrial Research and Development (total private and government R&D).

\(^{7}\)See, for example, (Baber et al., 1991; Roychowdhury, 2006; Gunny, 2010).

\(^{8}\)See Lieberman and Mahoney (2013) for a study in the US government and Atkin et al. (2014) for an experiment Pakistani manufacturing.
of long-term investment to meet analyst forecasts of earnings, as well as with a survey of executives at large US public firms in Graham et al. (2005): almost half of managers reveal that they would reject a positive net present value project if taking the project meant missing analyst forecasts of earnings.⁹ In a second empirical contribution, the paper applies the same regression discontinuity techniques to inspect incentives for CEOs. Managers who fail to deliver profits above consensus analyst expectations, even by a small amount, face precisely estimated drops of around 7% of total compensation. Furthermore, CEOs just failing to meet analyst targets face higher turnover within the current or next several years, an increase of around 16% relative to average levels. The finding of incentives for managers to deliver short-term results both helps to motivate real earnings manipulation but also concurs with a large literature on performance-based incentives.¹⁰

The reduced-form empirical portion of the paper reveals that manipulation of long-term R&D investments in the face of earnings targets is plausible and quantitatively meaningful in a sizable panel of large US public firms. Building on this empirical evidence, the second part of the paper quantifies a theoretical model linking earnings targets and aggregate growth. The model features managers of heterogeneous firms making R&D investment decisions together with pure paper or accounting manipulation choices subject to both persistent and transitory profitability shocks. R&D expenditures by firms result in random innovation arrival according to a quality ladder structure that aggregates in general equilibrium. Earnings forecasts, endogenously produced by an outside sector of analysts, provide short-term pressure on managers who seek to avoid costs resulting from failure to meet or beat earnings forecasts. The model is agnostic about the source of these costs for managers, but in practice earnings miss costs may be purely private to the manager due to reputational or career concerns (Dichev et al., 2013), borne by the firm due to higher external finance costs or disrupted communication costs with outsiders (Graham et al., 2005), or even the result of explicit manager compensation policies chosen by firms (Matsunaga and Park, 2001).¹¹

After laying out the model structure, the paper employs numerical solution methods and

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⁹Firms of course can use paper or accounting rather than operational or real decisions to boost earnings above analyst forecasts. Studies such as Burgstahler and Eames (2006) document that discretionary accruals appear to be unusually high for firms just meeting earnings targets.


¹¹In this paper, I allocate costs among these alternatives in a fashion which results in conservative estimates of the costs of earnings targets.
parametrizes the model using a combination of calibration and structural GMM estimation. Structural estimation here exploits the moments of R&D expenditures, sales, and forecast errors in a panel of firm-level data on thousands of large US public firms to produce a "Baseline" quantitative model economy. The main results center around comparison of the Baseline environment with a "No Targets" counterfactual economy in which there exist no costs or incentives for managers to meet or beat earnings forecasts.

First, the paper evaluates the implications of the counterfactual exercise for the earnings manipulation detection mechanisms used in the empirical portion of the paper as well as in the broader finance and accounting literature on earnings manipulation. The Baseline model with earnings targets for firms qualitatively reproduces the kinked earnings forecast error distribution in Figure I, with a disproportionate mass of firm-years with profits just above targets and a hollowing out the forecast error distribution below zero, while the counterfactual No Targets economy fails to reproduce a kinked distribution. Furthermore, while the No Targets economy produces a smooth distribution of R&D across across the zero forecast error threshold, the Baseline model leads to a cut in R&D growth for firms just meeting earnings targets, consistent with the empirical evidence from the first portion of the paper. Finally, the counterfactual exercise reveals insights into a rich and persistent body of research in corporate finance studying the release of information contained within earnings releases and surprises (Stein, 1989; MacKinlay, 1997). Firms in the Baseline model with mediocre profitability shocks are able to find the resources, either in long-term investment manipulation or paper obfuscation, to boost earnings above target. Therefore, firms that miss an earnings forecast in equilibrium are far less profitable than firms meeting or beating earnings forecasts, a quantitative difference which is positive but muted by contrast in the No Targets economy. Such considerations may help explain why firms report increased pressure from outsiders to explain or divulge more information about the prospects of the firm if they miss analyst expectations.

My quantitative model also reveals multiple facts about the R&D choices and value of firms subject to earnings pressure. On average, managers choose lower and more volatile R&D expenditures in the Baseline economy than in the No Targets case, because the presence of earnings targets induces short termism in the sense that forward-looking R&D policies respond to purely transitory or short-term shocks to profitability even if those shocks contain no information about the profitability of innovation in the long term. Sensitivity of
investment to short-term shocks due to earnings targets is reminiscent of the role of financial frictions in increasing consumption sensitivity to transitory income shocks in classic consumption-savings models from labor economics. Increased R&D volatility can itself impact the overall efficiency of R&D expenditures for firms even absent any effects on levels, since my theoretical structure allows for an empirically defensible amount of curvature or diminishing returns to R&D expenditures in innovation. Just as Barlevy (2004) theoretically links business cycle volatility to reduced growth in the macroeconomy in the presence of diminishing returns to investments, a similar mechanism in my model implies that firms subject to transitory profitability shocks and choosing more volatile R&D expenditures have fewer innovation arrivals than would result from a smoother long-term investment path.\footnote{At the microeconomic level, the Baseline economy with earnings targets is characterized by lower aggregate growth of around 2.25\% per year relative to a growth rate of around 2.31\% per year in the No Targets environment. The intuition behind lower aggregate growth in the economy with earnings targets is related to the intuition for reduced firm value in the same context. By exhibiting short termism and responding to purely transitory profitability shocks with long-term R&D investments in an environment with diminishing returns to R&D, manager earnings pressure causes a sort of “research misallocation,” whereby the efficiency of aggregate innovation declines. The misallocation from profitability volatility is distinct from but related to the literature on misallocation in Hsieh and Klenow (2009) or Restuccia and Rogerson (2008).} 

At the macroeconomic level, the Baseline economy with earnings targets is characterized by lower aggregate growth of around 2.25\% per year relative to a growth rate of around 2.31\% per year in the No Targets environment. The intuition behind lower aggregate growth in the economy with earnings targets is related to the intuition for reduced firm value in the same context. By exhibiting short termism and responding to purely transitory profitability shocks with long-term R&D investments in an environment with diminishing returns to R&D, manager earnings pressure causes a sort of “research misallocation,” whereby the efficiency of aggregate innovation declines. The misallocation from profitability volatility is distinct from but related to the literature on misallocation in Hsieh and Klenow (2009) or Restuccia and Rogerson (2008).\footnote{At the microeconomic level, the Baseline economy with earnings targets is characterized by lower aggregate growth of around 2.25\% per year relative to a growth rate of around 2.31\% per year in the No Targets environment. The intuition behind lower aggregate growth in the economy with earnings targets is related to the intuition for reduced firm value in the same context. By exhibiting short termism and responding to purely transitory profitability shocks with long-term R&D investments in an environment with diminishing returns to R&D, manager earnings pressure causes a sort of “research misallocation,” whereby the efficiency of aggregate innovation declines. The misallocation from profitability volatility is distinct from but related to the literature on misallocation in Hsieh and Klenow (2009) or Restuccia and Rogerson (2008).} Apparently small changes in permanent growth rates can translate into quantitatively large differences in welfare, because these changes are contin-
uously compounded over time. In my model, the removal of earnings targets results in an overall increase in welfare of 0.44% in consumption equivalent terms, i.e. consumption in each period would need to be increased by a factor of 0.44% in the Baseline to make the aggregate household as well off as in the No Targets balanced growth path.\textsuperscript{16} For comparison, recent quantitative estimates of the welfare gains from the elimination of business cycles are around 0.1-1.8%, the static gains from trade according to recent work could be approximately 2.0-2.5%, and a recent estimate of the social cost of systematically misinformed agents in equity markets is around 2.4%.\textsuperscript{17} Overall, short termism from earnings targets results in a quantitatively large distortion to long-term growth and the macroeconomy.

The main quantitative contribution of the paper should be interpreted as the delineation of the costs of earnings targets in terms of dynamic distortions to the efficiency of firm R&D and resulting falls in firm value, aggregate growth, and welfare. However, earnings targets may of course also provide benefits to firms or society as well, omitted from the baseline cost measurements.\textsuperscript{18} Several sources of benefits naturally suggest themselves. For example, earnings forecasts may contribute to more accurate valuation of firms or alleviate financial frictions at otherwise healthy firms. In fact, a series of theoretical and empirical papers including Midrigan and Xu (2014), Moll (Forthcoming), Buera and Shin (2013), and Buera et al. (2011), among others, indicates that alleviation of financial frictions can indeed reap quantitatively large efficiency gains from better allocation of resources throughout the macroeconomy.\textsuperscript{19} The second major source of potential benefits from earnings targets operates within firms through the provision of discipline to the managers of firms in the presence of agency conflicts. In agency environments, compensation schemes which explicitly or implicitly punish managers for failure to meet publicly observable earnings forecasts may lead to firm or social gains. The final portion of the paper analyzes multiple sources of agency

\textsuperscript{16}US consumption was around $11.500 billion in 2013 according to the BEA as of March 2014, so a 0.44% increase in consumption is equivalent to a permanent increase in consumption of around $51 billion each year. The overall welfare gains decompose into 1.32% dynamic gains from growth rate changes and a static loss of -0.86% due to higher initial investment in R&D.

\textsuperscript{17}See Krusell et al. (2009) for the welfare consequences of business cycles, Costinot and Rodriguez-Clare (2015) or Melitz and Redding (2013) for the welfare gains from trade, and Hassan and Mertens (2011) for the social cost of “near-rationality” in investment.

\textsuperscript{18}An interpretation of this sort is the norm for cost calculations in macroeconomics, with the most prominent example being the literature on the costs of business cycles (Lucas, 2003; Barlevy, 2004; Krusell et al., 2009). Gains from the elimination of business cycles may not be achievable if their elimination is costly.

\textsuperscript{19}Along these lines, Campello et al. (2014) exploits a natural experiment in Chinese financial regulation for identification of the impact of going public on firm outcomes, finding higher firm value, investment, and profitability firms with access to liquid markets for equity finance.
conflicts within the existing model of dynamic manager investment already used to estimate the costs of earnings pressure.

A wide literature on corporate investment in the face of agency conflicts between the owners and managers of firms, surveyed in Stein (2003), emphasizes that corporations are riddled with agency frictions leading to a wedge between the interests of managers and firms as a whole. Two particular forms of agency conflict which have received wide interest in the corporate finance literature on investment include unobservable shirking by managers (Edmans et al., 2009) and empire building motivated by private manager benefits from size or investment (Nikolov and Whited, 2010; Jensen, 1986). The exact nature of the agency conflicts turns out to matter qualitatively. When managers can provide low effort, I show that for strong enough shirking motives earnings targets within manager compensation contracts may improve value for firms as well as social welfare. The intuition is simple: the dynamic distortion to long-term investment, while costly, may be overwhelmed by the gains to levels obtained from increased discipline. In a second case, when firm agency conflicts are instead characterized by empire-building tendencies for managers, earnings targets may improve firm value by restraining the R&D investments of managers. If the social and private returns to R&D differ, however, firm restraint of R&D through earnings pressure on managers can lead to an exacerbation of underinvestment from the social perspective and an increase in social losses due to earnings targets.

Apparently, the model's implications depend crucially on assumptions about the exact form of agency conflicts within firms. Motivated by this consideration as well as the fact that the quantitative model used to measure costs from targets is not designed to precisely distinguish social and firm returns to R&D, I focus on qualitative results within my discussion of the benefits of earnings targets, demonstrating possibilities over a broad range of model parametrizations. Crucially, however, it is clear from the agency analysis within the paper that firm owners may achieve improvements in average value by explicitly conditioning manager compensation on meeting earnings forecasts, providing insight into the sources of earnings pressure.

The outline of the paper is as follows. Section 2 describes my data and lays out the empirical results linking earnings forecasts, long-term investment, and CEO incentives. Section 3 describes the quantitative model of earnings targets and growth, together with the numerical solution and estimation strategy. Section 4 performs the quantitative analysis es-
timating the costs of earnings targets for firms and the macroeconomy. Section 5 summarizes the potential agency benefits from earnings targets. Section 6 concludes. Appendixes follow describing the data (Appendix A), theory (Appendix B), and numerical solution method (Appendix C).

2 Data and Empirical Discontinuities

This section empirically investigates the manipulation and incentives surrounding earnings targets for firms. First, after joining analyst forecasts of earnings with the accounting releases of US public firms, my analysis reveals that firms just meeting earnings targets exhibit substantially lower long-term investment growth in R&D as well as broader intangibles. Similarly, CEOs at firms just failing to meet earnings targets receive discontinuously lower compensation and experience higher turnover rates.

This paper uses data from two main sources. First, earnings forecasts at the firm-analyst level totaling approximately 3.5 million observations over the period 1976-2010 come from the I/B/E/S database. Actual or realized values of firm “Street” earnings per share accompany the analyst forecasts from the I/B/E/S database, for around 153,000 firm-fiscal years covering about 16,000 firms. As emphasized by the accounting literature, Street earnings over which firms possess moderate discretion are the appropriate measure of earnings for my purposes, since Street earnings are more widely followed by financial market participants and observers than the net income measures reported in Compustat (Bradshaw and Sloan, 2002). The second source of data I use, for other firm outcomes, is Compustat data drawn from the annual accounting reports of public firms and also available at the firm-fiscal year level for around 160,000 observations and 17,000 firms from 1976-2010.

Linking the I/B/E/S and Compustat datasets results in a panel of around 33,000 firm-fiscal year observations with aggregated (median) analyst forecasts, Street realizations, and basic accounting fundamental data. Around 5,000 firms in 344 industries from 1982-2010 are available in the combined unbalanced panel. The data primarily consists of larger firms spanning a significant proportion of all economic activity in the United States. Around 13% of US employment is accounted for in the sample, along with 56% of all US R&D expenditures as well as total sales of around 30% of US GDP. To allow a concrete discussion

20For these comparisons, US employment is total nonfarm payrolls according to the BLS in 2010 (St. Louis FRED variable PAYEMS), while Compustat employment is the variable emp. US R&D expenditures are drawn from the National Science Foundation Survey of Industrial Research and Development in 2007,
of the careers and compensation of CEOs within US public firms, I also use Execucomp data where possible, allowing an analysis of total CEO compensation as well as turnover. Further information on the I/B/E/S and Compustat datasets, the sample restrictions imposed, the construction of individual variables, and the Compustat-I/B/E/S link is available in Data Appendix A.

If firms and managers face pressure or incentives to meet or beat earnings forecasts, then firms should avoid reporting profits just below analyst forecasts if possible, instead taking actions throughout their fiscal year to boost earnings above target. US accounting guidelines requiring expensing of long-term investments such as R&D from profits make them a choice target for opportunistic cuts in the face of earnings pressure. In this section I employ a flexible empirical tool, standard regression discontinuity techniques, to identify exactly this type of earnings manipulation through changes in the distribution of long-term investment as firms just meet the zero forecast error threshold. By the first application of regression discontinuity estimators to my knowledge in this context, I contribute to an accounting literature on real earnings manipulation which treats similar results as prima facie evidence of earnings manipulation by firms (Roychowdhury, 2006; Gunny, 2010).

Throughout the empirical analysis, my preferred measure of the forecast error for a particular firm \( j \) in year \( t \) is the realized value of Street earnings \( \text{Street}_{jt} \), minus the median analyst forecast of firm earnings made from the middle of the same fiscal year, \( \text{Street}^{\hat{f}}_{jt} \). This measure of earnings forecast errors is a standard one used by the earnings manipulation literature in accounting (Burgstahler and Eames, 2006). More details on construction of the median analyst forecast are available in the Data Appendix A. Since firms within my dataset can operate at such different scales in the cross-section, normalization of earnings data by a measure of firm size when comparing realizations across firms is crucially important (Burgstahler and Chuk, 2013). Therefore, I define forecast errors as the percentage difference in realized minus forecast earnings scaled by firm assets. Figure I above plots the resulting distribution of forecast errors.

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with R&D for the corresponding year from Compustat variable xrd. US nominal GDP in 2010 comes from the BEA (St. Louis FRED variable GDPA), with Compustat gross sales in variable sale.
### Table I: Estimates of Firm Regression Discontinuities in Forecast Errors

<table>
<thead>
<tr>
<th>Method</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
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<td>Local Linear</td>
<td>Local Linear</td>
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<td>Intangibles Growth</td>
<td>R&amp;D Growth</td>
<td>CEO Pay</td>
<td>CEO Turnover</td>
</tr>
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<td>Forecast Error</td>
<td>Forecast Error</td>
<td>Forecast Error</td>
<td>Forecast Error</td>
</tr>
<tr>
<td>Discontinuity</td>
<td>0.044</td>
<td>-2.52**</td>
<td>-1.99**</td>
<td>1.79***</td>
<td>-5.24**</td>
</tr>
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<td></td>
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<td>(0.93)</td>
<td>(0.99)</td>
<td>(0.90)</td>
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<td>3978</td>
<td>3978</td>
<td>2265</td>
<td>1548</td>
</tr>
<tr>
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<td>23271</td>
<td>23271</td>
<td>20895</td>
<td>7825</td>
</tr>
<tr>
<td>Relative to Mean</td>
<td>0.002%</td>
<td>-25.2%</td>
<td>-25.4%</td>
<td>6.9%</td>
<td>-16.1%</td>
</tr>
</tbody>
</table>

Note: ***, ** denote 5,10% significance. Standard errors are clustered at the firm level. The regression discontinuity estimation relies on local regressions and a triangular kernel, and the estimates above are the mean predicted differences for firms just meeting earnings forecasts relative to firms just failing to meet forecasts. Earnings forecast errors are Street earnings minus median analyst forecasts from a 2-quarter horizon, net of firm assets as a percentage. Investment Rate is the percentage tangible annual investment rate. Intangibles growth is annual percent selling, general, and administrative expenditures growth. R&D growth is annual percent research and development expenditure growth. CEO Pay is total CEO compensation scaled by firm assets. CEO Turnover is the percentage probability of CEO departure in the current or next 3 years.

* CEO Pay is total CEO compensation divided by firm assets and multiplied by 10000.
Forecast errors serve as the running variable in my regression discontinuity estimation with a cutpoint of zero. The first measure of investment I consider at firms contributes a type of placebo test: the tangible investment rate, equal to the ratio of capital expenditures to the book value of capital in the current year. Since tangible capital expenditure are depreciated from earnings over time rather than immediately expensed as incurred, their impact on current earnings and hence usefulness as a tool for earnings manipulation is diluted. By contrast, two measures of long-term investment, both immediately expensed from earnings in the period incurred, complement each other as outcome measures in my analysis. In addition to R&D expenditures during the year, I also consider a broader measure of “Intangibles” investment, the change in selling, general, and administrative (SG&A) expenditures within the firm. SG&A expenditures, a basic accounting item, enjoy more extensive coverage within the Compustat database and include not only R&D expenses but also a range of other nonproduction expenses such as management labor compensation, training expenditures, and advertising costs. Since these expenditures are intangible, i.e. not associated with investment in readily identifiable capital or production of a particular unit of output, they must also be expensed from firm earnings under US GAAP guidelines. However, a growing literature within economics and finance concludes that intangible expenditures such as R&D or SG&A in the long-term contribute to profitability for firms, to aggregate productivity over the business cycle or the long run, and to an improved explanation of stock returns in the cross section of firms.21

The first three columns of Table I above report regression discontinuity estimates of the predicted difference in the tangible investment rate, overall intangible expenditures growth, and R&D growth for firms just meeting their earnings targets in a given year relative to firms failing to meet an earnings target. These results are based on outcomes demeaned by firm then year, controlling for both permanent trend heterogeneity across firms in long-term investments as well as business cycle effects. I detect no discontinuity in tangible investment rates. By contrast, R&D growth and overall intangibles growth are both approximately 2-2.5% lower for firms just meeting an earnings target. The discontinuities are statistically significant at the 5% level and economically meaningful, representing a cut of around 25% of average annual long-term investment growth, respectively. Figures A.II-A.IV in Data Appendix A contain the predicted conditional mean of and discontinuities in tangible investment

and long-term investment growth for a range of values of the running variable.

Note that I provide no claim to a direct causal link in the regression discontinuity results of the form that is typically relied upon in the literature on regression discontinuity estimates in applied microeconomics (Lee and Lemieux, 2010). By contrast, the apparent endogenous “sorting” of firms to the right of the zero forecast error cutpoint, which would normally be considered a threat to identification, lies at the very core of my argument for the economic impacts of earnings targets. In a later section, I build an estimated quantitative model of R&D investment and earnings forecasts which demonstrates that reduced R&D growth around the zero forecast error threshold should be expected in the presence of incentives for firms to meet earnings targets but would otherwise be absent. Such results structurally support the convenient use of regression discontinuity methodology as a detection mechanism in this context.

Pressure to meet earnings targets can represent the product of explicit efforts of the distributed shareholders or boards of firms to provide discipline to CEOs and managers with interests divergent from those of the firm. Section 5 below explicitly incorporates agency conflicts between firms and managers such as shirking or empire building tendencies into a theoretical analysis of earnings targets and long-run growth. However, the remainder of this section applies the same flexible regression discontinuity techniques used above to an analysis of CEO incentives around earnings targets.

Discipline for managers may take multiple forms, evident in compensation or perhaps even threat of dismissal of career-concerned managers. A link between my Compustat sample of firms and the executive compensation and turnover data in Execucomp exists for some firm-years, allowing the construction of two measures of incentives for managers: CEO compensation and CEO turnover rates. CEO compensation includes base salary, bonuses, and the value of stock option-based pay for managers as a percentage of firm assets. CEO turnover represents an indicator for CEO departure in the current or next several years.22

Table I above also displays the estimated discontinuity in CEO total compensation and turnover rates for firms just meeting earnings targets or analyst forecasts. CEOs that gen-

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22 Data Appendix A contains further details on the construction of the incentive measures. The Execucomp-based measures do not differentiate between forced and unforced CEO turnover. One option would be to explicitly use classifiers of turnover events as forced and unforced based on news analysis or other algorithms, an approach taken by data in studies including Eisfeldt and Kühnen (2013), Jenter and Kanaan (Forthcoming), and Jenter and Lewellen (2010). However, incorporating all turnover events simultaneously avoids taking a stand on a particular classification algorithm for turnovers and also presumably is conservative for measurement of disciplinary CEO incentives.
erate earnings just at or above analyst forecasts earn approximately 0.02% more in total compensation relative to firm assets, while CEOs which just fail to deliver profits above expectations depart their firms in the near future with 5.2% higher probability. These statistically significant estimates represent around 7% and 16% changes in total compensation and turnover rates relative to mean levels, respectively. Figures A.V and A.VI in the Data Appendix A visualize the discontinuity in outcomes for CEOs for a range of values of the running variable. These results are consistent with a long literature in corporate finance and accounting that documents either discontinuities in manager compensation at earnings benchmarks or interaction between investment responses to earnings targets and CEO equity incentives (Matsunaga and Park, 2001; Edmans et al., 2013). However, they represent to my knowledge the first application of regression discontinuity methodology to the study of earnings targets and incentives.

3 Model of Earnings Targets and Growth

In this section I lay out a quantitative model of endogenous growth and earnings targets, followed by a discussion of the equilibrium concept and numerical solution method. Finally, I explain my parametrization of the model based on GMM structural estimation using firm-level moments from my Compustat and I/B/E/S sample.

3.1 Baseline Model Structure

Time is discrete, and a representative household subject to no aggregate uncertainty maximizes utility from a flow of aggregate consumption $C_t$ denominated in units of a final good. Period utility takes a standard constant relative risk aversion form with subjective discount rate $\rho$ and intertemporal elasticity of substitution $\frac{1}{\gamma}$. The household purchases shares $S_{jt}$ at price $P_{jt}$, receives dividends $D_{jt}$ from a fixed continuum of intermediate goods firms $j \in [0, 1]$, and inelastically supplies labor $L$ to a final goods sector at wage rate $w_t$. The household problem is

$$\max_{C_t, B_{t+1}, f S_{t+1}} \sum_{t=0}^{\infty} \frac{1}{1-\sigma} C_t^{1-\sigma}$$

$$C_t + B_{t+1} + \int_0^1 P_{jt} S_{jt} dj = R_t B_t + w_t L + \int_0^1 (P_{jt} + D_{jt}) S_{jt-1} dj.$$

The household also makes a savings choice $B_{t+1}$ in a one-period bond with zero net supply and interest rate $R_{t+1}$. As is standard, in general equilibrium with no aggregate uncertainty
household Euler equations will link growth rates and firm policies to this interest rate. Inelasticity supplied household labor is fixed at the amount \( L \). The numeraire final good is produced by a competitive, constant returns to scale, and price-taking sector which combines intermediate goods \( X_{jt} \) from each firm \( j \), and demands labor in the amount \( L_t^D \) to produce output \( Y_t \) in each period. As will be discussed in more detail below, each intermediate goods firm at time \( t \) possesses both an endogenously growing quality level \( Q_{jt} \), together with a stationary, exogenous quality or profitability shock \( a_{jt} + \varepsilon_{jt} \). Together, these quantities determine the marginal product of intermediate input \( X_{jt} \) from firm \( j \) in final goods production. The labor share is \( \beta \), and the final goods sector technology and optimization problem are

\[
Y_t = \frac{L_t^D \beta}{(1 - \beta)} \int_0^Z [Q_{jt}(a_{jt} + \varepsilon_{jt})]^{1-\beta} X_{jt}^{1-\beta} dj
\]

\[
\max_{t X_{jt}, L_t^D} \int_0^Z Y_t - p_{jt} X_{jt} dj - w_t L_t^D.
\]

The form of the final goods sector optimization problem above, which follows Acemoglu and Cao (2010), yields a standard isoelastic downward-sloping demand curve for variety \( j \), given by

\[
x_{jt} = p_{jt}^{\beta} L Q_{jt}(a_{jt} + \varepsilon_{jt}).
\]

Each member of the fixed continuum of intermediate goods firms \( j \in [0, 1] \) faces idiosyncratic but no aggregate uncertainty. Each firm \( j \) is associated with a manager in each period who determines monopoly pricing choice \( p_{jt} \), R&D investment \( z_{jt} \), and paper or accounting manipulation choice \( m_{jt} \). At time \( t \), firm \( j \) enjoys a long-term quality level \( Q_{jt} \), which is nonstationary and grows from R&D investments according to a quality ladder structure laid out below. Simultaneously, firm \( j \)'s stationary exogenous profitability shocks \( a_{jt} \) and \( \varepsilon_{jt} \) follow

\[
a_{jt} = \mu a(1 - \rho_a) + \rho_a a_{jt-1} + \zeta_{jt}, \quad \zeta_{jt} \sim N(0, \sigma_a^2)
\]

\[
\varepsilon_{jt} \sim N(0, \sigma_e^2).
\]

\[23\] The intermediate goods firm profitability shock is the sum of a persistent component \( a_{jt} \) and transitory component \( \zeta_{jt} \).

\[24\] Throughout the paper, I abstract from entry with a fixed set of intermediate goods firms. This assumptions is made more palatable by my structural estimation of the model with data from large public firms with lower exit hazards, but of course also means that I abstract from the rich Schumpeterian interactions between entry and innovation studied in many endogenous growth models starting with Aghion and Howitt (1992).
The transitory shock process $\varepsilon_{jt}$ buffets firm profitability in each period, while the AR(1) process $a_{jt}$ persists. A number of recent papers apply a similar basic structure, decomposing volatility affecting firm or economy-wide investment choices into persistent and transitory components, and of course such breakdowns have a long history in labor economics. To understand the importance of both long-term quality $Q_{jt}$ and combined short-term profitability $a_{jt} + \varepsilon_{jt}$ to the firm, first decompose variable profits from sales of intermediate inputs to the final goods sector $\Pi_v(Q_{jt}, a_{jt}, \varepsilon_{jt}, p_{jt})$. Variable profits are simply equal to revenue minus total production costs. Intermediate goods firms can convert final goods output to variety $j$ of intermediate output at constant marginal cost $\psi$, yielding

$$\Pi_v(Q_{jt}, a_{jt}, \varepsilon_{jt}, p_{jt}) = p_{jt}X_{jt} - \psi X_{jt}.$$  

The isoelastic form of the final goods sector’s demand for input $j$ implies an optimal constant markup pricing rule for $p_{jt}$ over marginal cost $\psi$, so that eventually variable profits take the following homogenous form in $Q_{jt}$:

$$\Pi_v(Q_{jt}, a_{jt}, \varepsilon_{jt}, p_{jt}) = \beta Q_{jt}(a_{jt} + \varepsilon_{jt})L.$$  

Firm $j$’s scaled R&D policy $z_{jt}$ leads to a total expenditure of $z_{jt}Q_{jt}$ and results in an innovation with probability $\Phi(z_{jt}) = A z_{jt}^\alpha$. The parameter $\alpha \in (0,1)$ governs the elasticity of innovation arrival with respect to R&D expenditure. Innovations embody a proportional improvement up a quality ladder by amount $\lambda > 1$, so that the level of long-term quality $Q_{jt+1}$ for firm $j$ in period $t+1$ is

$$Q_{jt+1} = \frac{\lambda Q_{jt}}{\max(Q_{jt}, \omega Q_{t+1})}, \quad \text{with probability } \Phi(z_{jt})$$

$$Q_{jt+1} = 1 - \Phi(z_{jt}), \quad \text{with probability } 1 - \Phi(z_{jt}).$$

Eventually, if firm $j$ lags and does not innovate for long enough, the firm will receive a diffusion of some small fraction $\omega$ of the average quality level $Q_{t+1}$ of the economy as a whole.

Managers also make discretionary accounting choices which can affect reported earnings. Paper manipulation by public firms can be accomplished through judicious use of tools such

\footnote{Such papers for firm investments include Aguier and Gopinath (2007), Franco and Philippon (2007), Roys (2011), and Gourio (2008), while Blundell et al. (2008) and many others consider household persistent and transitory shock decompositions in the presence of a consumption/savings choice.}

\footnote{For notational convenience, following Acemoglu and Cao (2010), I make the assumption that $\omega = 1 - \frac{1}{\lambda}$, leading to a monopoly price of $p_{jt} = \frac{1 - \lambda}{\lambda} = 1$.}

\footnote{This diffusion structure again follows Acemoglu and Cao (2010) and is useful to deliver existence of a stationary distribution of normalized firm-level quality levels $Q_{jt}$ on a balanced growth path for the economy.}
as heavy revenue accrual or recognition into earnings within a fiscal period. Through their accounting discretion, managers may also shift their reported “Street” earnings from a value which would be determined by strict application of GAAP principles to the more flexible value reported in the financial press. However, activities such as accrual manipulation bear costs for at least two reasons. First, by recognizing revenues now firms constrain their ability to accrue such revenues to earnings in future. Second, more discretionary accounting manipulation presumably involves more disruption of manager time, higher auditor expenses, or even higher probability of fraud detection and prosecution.\textsuperscript{28} In the model, I allow for discretionary earnings manipulation at a cost. By choosing manipulation level \(m_{jt}\), firm \(j\) can induce a net paper shift of its reported earnings by \(m_{jt}Q_{jt}\), subject to a quadratic cost \(\gamma_m m_{jt}^2\). Overall earnings \(\Pi^{Street}_{jt}\) are defined as variable profits net of R&D expenditures and paper manipulation:

\[
\Pi^{Street}_{jt} = \Pi_v(Q_{jt}, a_{jt}, \varepsilon_{jt}, p_{jt}) - z_{jt}Q_{jt} + m_{jt}Q_{jt}.
\]

For intermediate goods firms, forecasts of earnings evolve over time based on the rational projections of an outside sector of identical equity analysts. Since earnings \(\Pi^{Street}_{jt}\) are homogeneous in long-term quality \(Q_{jt}\), analysts forecast normalized earnings \(\pi_{jt} \equiv \Pi^{Street}_{jt}/Q_{jt}\). Analysts understand the structure of the economy, including the exogenous shock processes and the potential for earnings manipulation by firms. Forecasters possess an information set at time \(t\) consisting of lagged normalized earnings \(\pi_{jt-1}\), consistent with survey evidence in Brown et al. (2014) revealing that large fractions of equity analysts incorporate recent earnings performance into the production of their earnings forecasts. Further motivated by empirical evidence suggesting that analysts face career concerns and pressure to produce accurate forecasts of earnings,\textsuperscript{28} forecasters in the model choose forecasts \(\pi^f_{jt}(\pi_{jt-1})\) to minimize the following expected quadratic loss function:

\[
\pi^f_{jt} = \arg \min_{\pi^f} \mathbb{E}_{\pi_{jt-1}} (\pi^f - \pi_{jt})^2.
\]

Optimal forecasts in the model satisfy \(\pi^f_{jt}(\pi_{jt-1}) = \mathbb{E}(\pi_{jt}|\pi_{jt-1})\), and firm \(j\) is aware of its earnings forecast \(\pi^f_{jt}\) when making R&D investment and paper manipulation choices in period \(t\).

\textsuperscript{28}See Dichev et al. (2013) for a survey-based discussion of the costs of earnings manipulation perceived by managers at large firms in the United States. See Bradshaw and Sloan (2002) for a further discussion of the distinction between Street and GAAP earnings in practice.

\textsuperscript{29}See, for example, Hong et al. (2000), Hong and Kubik (2003), Hong and Kacperczyk (2010), or Marinovic et al. (2012).
The manager of firm $j$ maximizes the expected discounted flow of their personal utility.\footnote{Managers discount their flow utility using the interest rate $R$ implied by household decisions, allowing in general equilibrium for feedback from growth rates and interest rates to manager decisions. Such an assumption is useful so that with appropriately chosen parameters the manager optimization problem nests firm profit maximization. In Theory Appendix B, I provide details of a microfoundation of this discounting structure with overlapping generations of one-period-lived managers selling a manager franchise onwards to the next period’s manager after choosing firm policies. If the next period’s manager must borrow from the household to fund their purchase of the manager position, then in equilibrium manager policies reflect the full stream of all future managers’ returns and discount the future at the rate $\frac{1}{R}$.} Their decisions solve the following problem:

$$\max_{f_{t}, m_{j}, \gamma_{j}} \mathbb{E} \left( \sum_{t=0}^{T} \frac{1}{R} D_{jt}^{M} \right).$$

Manager compensation depends on a constant share $\theta_{d}$ of ownership in their firm. Given manager choices for R&D, accounting manipulation, and pricing, firm dividends in period $t$ are given by variable profits minus R&D expenditures and resource costs of paper manipulation $m_{jt}$

$$D_{jt} = \Pi_{r}(Q_{jt}, a_{jt}, \epsilon_{jt}, p_{jt}) - z_{jt}Q_{jt} - \gamma_{m}^{2}m_{jt}Q_{jt},$$

so that manager flow utility, linear in their consumption and other payoffs, is given by

$$D_{jt}^{M} = \theta_{d}D_{jt} - \xi \left( \Pi_{r}^{Street} < \Pi_{r}^{I} \right) Q_{jt}.$$

The first term simply represents the manager’s share of firm dividends. The second term crucially embodies the impact of firm earnings forecasts on the manager objective and hence firm policies. A manager who fails to deliver earnings which meet or beat analyst expectations suffers a fixed loss governed by the parameter $\xi \geq 0$. Note that when $\theta_{d} = 1$ and $\xi = 0$ the manager problem nests firm profit maximization. In Section 5 I will explicitly examine the potential for other agency frictions such as a manager taste for shirking on effort or empire-building, but these channels are shut down in this baseline framework for cost measurement. Therefore, the manager loss conditional upon a miss, $\xi Q_{jt}$, represents the only current departure from pure value maximization by managers and bears further discussion.

The discontinuous, fixed nature of the miss cost is a natural choice given the kinked forecast error distribution in Figure 1 as well as the evidence for discontinuous manager incentives in Section 2.\footnote{By choosing a fixed cost specification to match such kinked patterns, I follow papers such as Gourio and Roys (2012) and Garicano et al. (2013), which employ nonconvex regulatory or taxation costs to generate kinks in model firm size distributions to match distributions in French firm-level data characterized by kinks like those in Figure 1.} In principle, earnings miss costs can represent three separate
sources of loss for managers

\[ \xi = \xi_{\text{manager}} + \theta_d \xi_{\text{firm}} + (1 - \theta_d) \xi_{\text{pay}}. \]

The first potential component of miss costs for managers, \( \xi_{\text{manager}} \), is purely private. Sources include career or reputational concerns for managers, as surveyed managers report that reputational concerns loom large (Dichev et al., 2013). Alternatively, managers may suffer increased effort costs due to higher rates of more negatively focused communications with outsiders upon an earnings miss (Yermack and Li, 2014).

The second potential component of miss costs, \( \xi_{\text{firm}} \), reflects any adverse resource or disruption costs consequences borne by firms rather than directly by managers for failure to meet analyst expectations. Such firm-borne costs would affect managers indirectly through their impact on firm dividends and through manager ownership shares \( \theta_d \). Surveyed managers view efforts to avoid earnings misses as important to maintain a low cost of external finance through their firm’s stock price, to avoid triggering debt covenants, and even to avoid higher likelihood of lawsuits from shareholders (Graham et al., 2005).

The third and final component of miss costs, \( \xi_{\text{pay}} \), represents the potential for a firm to explicitly condition manager compensation on meeting earnings targets. In particular, if exogenous compensation includes not only a divided share but also an amount \( \xi_{\text{pay}} Q_{st} \) clawed back conditional upon a miss, then the net loss to a manager from this channel is given by \( (1 - \theta_d) \xi_{\text{pay}} \). Empirically, managers failing to meet earnings benchmarks suffer reduced bonuses (Matsumaga and Park, 2001), and the empirical evidence from Section 2 suggests that overall compensation is discontinuously lower for managers just failing to meet analyst forecasts.

My structural estimation approach in Section 3 for quantifying a manager’s cost of missing an earnings target, will identify only the combined cost \( \xi \) rather than the three individual components \( \xi_{\text{manager}}, \xi_{\text{firm}}, \) and \( \xi_{\text{pay}} \). When making quantitative statements about the overall cost of earnings targets in Section 4, I conservatively assume that the entirety of the term \( \xi \) represents personal costs \( \xi_{\text{manager}} \). Any changes in firm value or household welfare due to distorted manager policies are therefore due to the policies themselves rather than a direct mechanical contribution from disruption costs \( \xi_{\text{firm}} \).
3.2 Balanced Growth Path Equilibrium and Numerical Solution

The model outlined above admits a balanced growth path equilibrium at which all model aggregates, including average quality \( Q_t = \int_0^1 Q_{jt} d\gamma \), grow at constant rate \( g \). Theory Appendix B outlines the full equilibrium definition, which involves four major optimizing components: 1) optimal household consumption and savings decisions \( C_t, S_{jt}, \) and \( B_{t+1} \) given the budget constraint, 2) competitive final goods firm optimization over intermediate goods \( X_{jt} \) and labor demand \( L^P_t \), 3) intermediate goods firm manager optimization over monopoly pricing \( p_{jt} \), R&D investment \( z_{jt} \), and paper earnings manipulation choices \( m_{jt} \), and 4) rational analyst forecasts of earnings \( \pi^{f}_{jt} \) for each firm. An economy-wide resource constraint, labor market clearing, asset market clearing, and aggregation consistency conditions complete the characterization of general equilibrium for the model.

I use numerical techniques to solve the model. Given homogeneity of manager returns in long-term quality, I first normalize their dynamic problem by the average quality level in the economy \( Q_t \). This normalization yields a stationary recursive formulation with four state variables: \( q \) (normalized endogenous intermediate goods firm long-term quality), \( a \) (exogenous persistent profitability), \( \varepsilon \) (exogenous transitory profitability), and \( \pi^f \) (endogenous analyst forecasts of earnings). Here, I notationally omit dependence on \( j \) or \( t \) for clarity, indicating future and lagged values by 0 and 1, respectively. Throughout the paper, I solve a discretized version of the manager problem using standard numerical dynamic programming techniques (Judd, 1998). I also rely upon a polynomial approximation to the analyst expectation \( \pi^f = \mathbb{E}(\pi|\pi_1) \). For a given parametrization of the model and solution to the manager’s problem, I compute a stationary distribution \( \mu(q, a, \varepsilon, \pi^f) \) of firm states.

Model aggregates are a function of the stationary distribution \( \mu \). My algorithm for full general equilibrium solution of the model along a balanced growth path, explained in more detail in Numerical Appendix C, involves a hybrid damped fixed-point and bisection algorithm iterating over the growth rate \( g \), interest rate \( R \), and forecast function \( \pi^f(\pi_1) \) such that the following three fixed points are satisfied:

1. The constant interest rate \( R \) and growth rate \( g \) satisfy the household Euler equation:

   \[
   R = \frac{1}{\rho}(1 + g)^\sigma
   \]

2. An economy-wide growth rate equal to \( g \) results from the aggregation of intermediate
Table II: Outside Calibration of Common Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Explanation</th>
<th>Source, Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\sigma$</td>
<td>CRRA</td>
<td>Hall (2009), 2.0</td>
</tr>
<tr>
<td>$\rho$</td>
<td>Discount rate</td>
<td>Annual interest rate $\approx 4%$, 0.98</td>
</tr>
<tr>
<td>$\beta$</td>
<td>Labor share</td>
<td>NIPA, 0.67</td>
</tr>
<tr>
<td>$L$</td>
<td>Human capital</td>
<td>Normalization, 1.0</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>R&amp;D curvature</td>
<td>Acemoglu et al. (2013), 0.5</td>
</tr>
<tr>
<td>$\lambda$</td>
<td>Quality step</td>
<td>25% increment, 1.25</td>
</tr>
</tbody>
</table>

Note: The table displays the notation (first column) as well as an explanation (second column) of each model parameter fixed by outside calibration. The third columns lists the source and value of each common parameter, separated by a comma.

goods firm R&D investment policies $x$ and the innovation arrival function $\Phi(z)$:

$$1 + g = \frac{Q^0}{Q} = \int_{\phi > 0} \int_{\omega(1 + g)}^{\infty} \Phi(z) q d\mu(a, \varepsilon, q, \pi_f)$$

3. Analyst expectations of earnings are consistent with the equilibrium distribution $\mu$:

$$\pi_f = E_\mu(\pi|\pi_{-1})$$

3.3 Estimation with Firm-Level Data

Numerical analysis of the baseline model laid out above requires fixing the values of twelve parameters. Parametrization for the most part follows a structural estimation strategy based on GMM using firm-level moments from the joint sample of Compustat and I/B/E/S data on US public firms. However, before estimating the model, I calibrate externally half of the parameters involving common quantities from the macroeconomics or innovation literature. Table II reports the values of these parameters.

The model period is one year. Together, an intertemporal elasticity of substitution of 0.5 or $\sigma = 2$, a subjective discount rate of $\rho = 1/1.02 \approx 0.98$, and a growth rate of near 2% yield annual interest rates of around 4%. A labor share of $\beta = 2/3$ matches standard values in the quantitative macroeconomics literature, and a value of $\lambda = 1.25$ implies long-term quality increases of 25% upon innovation arrival.\footnote{Absent direct information on innovation arrival at firms in my data, I choose to fix this quality step size at the round value of 25%. Note that structural estimates of the quality step size from Peters (2013)} I normalize labor supply to $L = 1$.\footnote{Absent direct information on innovation arrival at firms in my data, I choose to fix this quality step size at the round value of 25%. Note that structural estimates of the quality step size from Peters (2013)}
Table III: Data and Model Moments Used for GMM Estimation

<table>
<thead>
<tr>
<th>Moment, %</th>
<th>Data</th>
<th>Baseline</th>
<th>No Targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate Growth Rate, g</td>
<td>1.98</td>
<td>2.25</td>
<td>2.31</td>
</tr>
<tr>
<td>Var(R&amp;D Growth)</td>
<td>9.10</td>
<td>7.65</td>
<td>2.58</td>
</tr>
<tr>
<td>Var(Sales Growth)</td>
<td>6.69</td>
<td>4.83</td>
<td>4.83</td>
</tr>
<tr>
<td>Var( Forecast Error)</td>
<td>13.93</td>
<td>5.85</td>
<td>4.75</td>
</tr>
<tr>
<td>Cov(R&amp;D Growth, Sales Growth)</td>
<td>2.78</td>
<td>2.52</td>
<td>1.66</td>
</tr>
<tr>
<td>Cov(R&amp;D Growth, Forecast Error)</td>
<td>-0.14</td>
<td>-0.22</td>
<td>0.17</td>
</tr>
<tr>
<td>Cov(Sales Growth, Forecast Error)</td>
<td>0.68</td>
<td>1.52</td>
<td>3.12</td>
</tr>
</tbody>
</table>

Note: The data moment values from the covariance matrix of sales growth, R&D growth, and earnings forecast errors above are computed from the estimation sample comprising a panel of income statement and earnings forecast data US firms from Compustat and I/B/E/S, with 4,838 firms and 32,554 firm-years from 1982-2010. The aggregate growth rate is the mean US per capita real GDP annual growth rate over the same period from the BLS and BEA. The Baseline moments are computed from the stationary distribution of the estimated baseline model, while the No Targets figures are computed from the counterfactual model stationary distribution with no manager miss cost of missing an earnings target, i.e. \( \alpha = 0 \).

Based approximately on firm-level structural estimates of the relationship between R&D expenditures and patenting in Acemoglu et al. (2013), I fix the elasticity of innovation arrival to R&D expenditures at \( \alpha = 0.5 \). Note that robustness checks to alternative values of calibrated parameters, reported in Numerical Appendix C, result in similar conclusions.

The GMM approach requires selection of informative moments to use in identification of the remaining six parameters of the model, including the persistence and volatilities of profitability shocks \( a_{jt} \) and \( \epsilon_{jt} \) (parameters \( \rho_a, \sigma_a, \) and \( \sigma_\epsilon \)),\(^{33}\) as well as the magnitude of manager miss costs associated with earnings targets \( \xi \), the productivity level for innovation \( A \), and the costs of paper accounting manipulation \( \gamma_{tm} \). Table III lists the seven selected moments together with their values in the data and model.

With seven moments and six parameters, the estimation algorithm is overidentified GMM. The mapping between parameters and moments in the model is joint and not one-to-one. However, it is useful to intuitively lay out the arguments for identification here before laying out the structure of the estimation routine. The aggregate growth rate \( g \), around 2% in the US data from 1982-2010, is heavily influenced by the choice of productivity level \( A \), since

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\(^{33}\)I normalize the mean level of persistent profitability \( \rho_a = 1 \) in the quantitative analysis, leaving only persistence and volatility parameters remaining.
this determines the average rate of innovation arrival and quality improvement in the model.

A discussion of identification of the remaining parameters relies upon the covariance matrix of percentage R&D growth, sales growth, and forecast errors.\textsuperscript{34} Separately decomposing the variation in profitability at the firm level into persistent and transitory components depends crucially upon both the volatilities of R&D and sales growth but also on the covariance of R&D and sales growth. Higher persistence $\rho_x$ for profitability shocks leads to higher covariance of R&D and forecast errors. Volatility in both the persistent and transitory profitability processes (higher $\sigma_\alpha$ or $\sigma_\varepsilon$) leads to more variable sales growth and forecast errors, but increases in persistent profitability volatility and higher transitory shock volatility lead to distinct influences on R&D growth and forecast error volatility. A larger manager miss cost $\xi$ upon missing an earnings target leads to more volatile R&D policies as managers react to and compensate for adverse transitory profitability shocks by cutting R&D growth. This effect in turn creates negative comovement of R&D growth with forecast errors in the earnings process. Finally, by engaging in accounting manipulation $m$ in the model, firms reduce the comovement between sales growth and forecast errors when more permissive and lower values of $\gamma_m$ are present. To provide further perspective on the underlying mapping, absent a formal proof of identification, Appendix Figure C.III provides a chart with the numerical elasticities of the model moments with respect to the estimated parameters.

Now that a combination of macroeconomic and microeconomic moments exist for estimation of the model, I can lay out the basics of the GMM estimation algorithm here for the vector of parameters $\theta = (\rho_x, \sigma_\alpha, \sigma_\varepsilon, A, \gamma_m, \xi)^0$, with the rest of the details available in the Data Appendix A. First, after choosing a weighting matrix $W$, I estimate $\hat{\theta}$ through numerical minimization of the objective

$$\hat{\theta} = \arg \min_{\theta} [m(\theta) - m(X)]^0 W [m(\theta) - m(X)],$$

where $m(X)$ and $m(\theta)$ are the vector of moments from the data $X$ and model with parameters $\theta$, respectively.\textsuperscript{35} The moment weighting matrix $W$ I use is based upon the inverse of the covariance matrix of the moments in the data, but also, given its importance for an

\textsuperscript{34}Forecast errors are equal to the percentage difference between the realized Street earnings value and analyst forecasts of earnings within a period. Also, the model and data definitions of each growth rate are Davis and Haltiwanger (1992)-style robust and bounded percent growth rates. A percentage growth rate for variable $x$ equals $\% \Delta x_{jt} = \frac{2x_{t+1} - x_{t+1}}{x_{t+1} + x_{t+1}}$ in both the data and the model.

\textsuperscript{35}The numerical minimization is carried out using a standard global stochastic numerical optimization routine called particle swarm optimization which is simple, robust, and broadly comparable to other global stochastic optimization routines such as simulated annealing.
Table IV: GMM Parameter Estimates

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Explanation</th>
<th>Estimate (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\rho_a$</td>
<td>Prof. persistence</td>
<td>0.903 (0.032)</td>
</tr>
<tr>
<td>$\sigma_a$</td>
<td>Prof. volatility</td>
<td>0.070 (0.003)</td>
</tr>
<tr>
<td>$\sigma_\varepsilon$</td>
<td>Transitory shock vol.</td>
<td>0.099 (0.007)</td>
</tr>
<tr>
<td>$A$</td>
<td>R&amp;D level</td>
<td>0.256 (0.115)</td>
</tr>
<tr>
<td>$\xi$</td>
<td>Earnings miss disruption</td>
<td>0.001 (0.0005)</td>
</tr>
<tr>
<td>$\gamma_m$</td>
<td>Manipulation cost</td>
<td>0.290 (0.358)</td>
</tr>
</tbody>
</table>

Note: The parameter estimates above are computed from an unbalanced panel of income statement and earnings forecast data, with 4,838 firms and 32,554 firm-years from 1982-2010 in the US, together with data on the US per capita real GDP growth rate over the same period. The estimation procedure is standard overidentified GMM, with a moment covariance matrix reflecting time series correlation of the aggregate growth rate using a stationary bootstrap and arbitrary time series correlations within firm-level clusters for all microeconomic moments. Optimization was performed using particle swarm optimization, a stochastic global minimization routine. The weighting matrix is the inverse moment covariance matrix, with approximately 10 times extra weight placed on the aggregate moment. Asymptotics are computed in the number of firms while assuming independence between aggregate and microeconomic moments in the data.

An investigation of growth, places additional weight on the aggregate growth rate in the data. With point estimates $\hat{\theta}$ from the numerical minimization in hand, the asymptotic covariance matrix of the estimates follows standard GMM formulas.\(^{36}\)

Table IV records the estimated parameters and standard errors based on my combination of aggregate and firm-level data in the baseline model. The persistent portion of profitability is highly autocorrelated, with $\rho_a$ approximately equal to 0.9, and the combination of persistent and transitory volatility, $\hat{\rho} \frac{\sigma_\alpha^2}{\sigma_\alpha^2 + \sigma_\varepsilon^2}$, is moderate at around 12% annually.\(^{37}\) These profitability parameters are quite precisely estimated. Comfortingly, the persistence and volatility estimates are comparable to the structural estimates of the parameters of firm-level productivity or profitability processes found in both Gourio and Rudanko (2014) as well as Hennessy and Whited (2007), which are also based on dynamic firm-level problems and US Compustat data. Naturally, however, I estimate higher persistence in the profitability shock $\alpha_{jt}$ because I also include purely transitory variation $\varepsilon_{jt}$.

The accounting manipulation and R&D productivity parameters $\gamma_m$ and $A$ are in model units difficult to map directly to observable quantities. However, we can naturally check

---

\(^{36}\)See for example, the derivations and formulas in Gourieroux and Monfort (1997), but note that the stationary distribution of the model state variables is directly computable and doesn’t require simulation. Therefore, my approach can be classified as GMM and avoids the need for the variance inflation factor of SMM estimation.

\(^{37}\)Although the profitability processes are defined in levels, a profitability mean of 1 allows us to apply the log approximation to these deviations and interpret them approximately as percentage deviations.
for the plausibility of the estimated costs $\hat{\xi}$ by expressing them in terms of observables. In the baseline model, managers are indifferent between missing an earnings targets and a loss of around 3.6% of firm revenues on average, with the miss cost statistically distinguishable from zero with high precision. Benchmarks for direct comparison with the 3.6% figure are scarce. However, Taylor (2010) structurally estimates a perceived cost to firms of CEO turnover of around 5.9% of firm assets, equal to 7.2% of firm revenues given the mean assets to sales ratio in my sample. CEO firing events are rare at a 2% rate (Taylor, 2010) relative to earnings misses, which occur at a 47% rate in my sample. Therefore, my lower estimated earnings miss costs are plausible. Additionally, macroeconomics has for decades devoted considerable energy to quantifying the costs of price adjustment at firms, another fixed cost crucial to firm decision making. Zbaracki et al. (2004) provides estimates of the costs at a large firm associated with a price change and dominated by costs of customer negotiation and communication together with lost manager time. These total expenses sum to about 1.2% of firm revenues in each annual price-changing cycle. Given that price changes predictably occur each year within firms, a lower direct estimate of price change costs relative to my structurally estimated costs perceived by managers from earnings misses is reassuring.

The overidentified and highly nonlinear structure of the model implies that we may not expect an exact match between model and data moments. However, Table III demonstrates that the Baseline model with incentives to meet earnings forecasts leads to a broadly successful fit to the data moments.\footnote{Note, however, that although the Baseline model arguably matches the data moments in a qualitative fashion, the amount of data used in GMM estimation of the model implies that the $J$-test of overidentifying restrictions for the model is quite stringent, producing a strong rejection of the model.} In particular, the Baseline delivers an aggregate growth rate near the 2% level seen in the data, together with substantial variation in R&D growth and sales growth rates analogous to the amount in the data. Note that the model delivers less volatile forecast errors than observed in the data. However, I am able to reproduce several features of the covariance structure of the micro data that a model without earnings targets (moments also reported in Table III) is unable to provide. In particular, in both the Baseline and the data, forecast errors negatively covary with R&D growth. In other words, the presence of earnings targets implies that cuts to R&D growth can be driven in the model by a desire to meet or beat earnings forecasts and therefore be correlated with higher forecast errors. By contrast, the model without earnings targets, in which R&D innovations are exclusively motivated by persistent profitability innovations, naturally produces a positive
correlation of high earnings reports and forecast errors with R&D growth. Furthermore, the presence of earnings targets in the Baseline causes dependence of R&D policies on transitory shocks to profitability, increasing both the volatility of R&D growth and the covariance of R&D growth and sales growth in line with the data, while a model without a motive to meet earnings forecasts underpredicts the covariation seen in the data. Finally, the paper obfuscation in a model with earnings targets leads to less covariance between sales growth and forecast errors, while a model without earnings targets overpredicts this quantity. I conclude that my model is both broadly consistent with the firm-level data.

4 Estimated Costs of Earnings Targets

With estimated model parameters in hand, I now evaluate the impact of earnings targets by comparing my baseline economy with a counterfactual “No Targets” economy in which there are no manager costs of missing an earnings forecast. My comparison naturally involves two steps. First, I decompose the contrasting implications of the Baseline economy and the No Targets model for a set of outcomes widely used by accounting studies to detect earnings manipulation. The presence of pressure to meet earnings targets endogenously delivers a kinked forecast error distribution, lower R&D growth for firms just meeting earnings targets, as well as a stark separation of profitability between firms meeting and missing profit forecasts. Each of these outcomes is absent or muted in the counterfactual No Targets economy. Second, once I have established that my model can capture the salient features of earnings manipulation seen in the firm-level data, I then move to a discussion of the economic costs of earnings targets. Earnings benchmarks force a distortion to the dynamic long-term investment decisions of firms in the Baseline model. Because of this effect, I find that the No Targets economy exhibits quantitatively meaningful increases in aggregate growth rates and household welfare, lower and more volatile firm R&D expenditures, and higher firm value on average.

4.1 Detecting Earnings Manipulation in the Baseline Model

The accounting literature stresses the importance of the earnings forecast error distribution as a detection mechanism for earnings manipulation, as evident from the bunching or kinks in Figure I. Within my model, Figure II displays the unconditional distribution of earnings forecasts errors in the Baseline (in red bars) and the counterfactual No Targets (in black
bars) economies. Crucially, the model with earnings targets delivers bunching of the forecast error distribution at zero, as managers engage in both real and paper earnings manipulation to reach earnings forecasts, as well as a hollowing out of the distribution of earnings forecast errors below zero.\(^{39}\) By contrast, the model without earnings targets displays a smoothly varying distribution of forecast errors without the empirically evident kinks.

In addition to overall changes in the link between R&D and profitability, I can investigate within the model another empirical detection method for R&D manipulation used in the empirical section above and by a range of accounting studies.\(^{40}\) Figure III displays the conditional mean of percentage R&D growth for firms in the Baseline (in red) and No Targets economy (in black), given different values for forecast errors \(\pi - \pi^f\). While R&D growth varies rather smoothly across the zero forecast error benchmark in the No Targets economy, firms which are incentivized to meet earnings forecasts in the Baseline model have R&D growth rates around 1% lower than firms that fail to meet an earnings target. Clearly a finding of reduced R&D growth by firms just meeting earnings targets fits naturally into a world with high-pressure earnings forecasts but is not consistent with a No Targets economy.

A rich and persistent strand of literature within both corporate finance and accounting seeks to understand the determinants of and information content within earnings releases (MacKinlay, 1997; Nichols, 1989; Kasznik and McNichols, 2002; Liu et al., 2009). In a seminal theoretical contribution, Stein (1989) suggests that myopic distortions of investment by firms endogenously arise in order to boost short-term earnings of profitability in a "signal-jamming equilibrium" with earnings manipulation. An imperfectly informed market expects manipulation and therefore updates its inferences about firms with poor earnings reports particularly harshly. Anecdotally, this intuition is consistent the survey of large US firm managers in Graham et al. (2005), where one participant reported that "if you see one cockroach, you immediately assume that there are hundreds behind the walls, even though you may have no proof that this is the case."

In the context of my model, Figure IV shows quantitative evidence of exactly this type of selection into meeting earnings targets, with firms that meet forecasts in the Baseline

\(^{39}\)The horizontal axis, based on normalization by long-term firm quality \(Q_{it}\) rather than a notion of firm assets, is not directly comparable to the earnings forecast error distribution displayed in Figure I. However, the long-term value and scale of a firm in the model depends heavily upon quality, in a similar fashion to the heavy dependence of scale upon assets in the estimation sample.

\(^{40}\)See the analysis in Roychowdury (2006), Guny (2010), Baber et al. (1991), and Burgstahler and Eames (2006), among others.
model 146% more profitable on average (as measured by the persistent shock $a_{t}$) than firms that miss a target. By contrast, firms in the No Targets economy that miss an earnings target are only 11% less profitable on average than firms that meet their targets. Clearly, in the Baseline model, observers of firms would be justified in inferring quite poor profitability prospects for firms failing to meet an earnings forecast. I view the results in Figure V as potentially suggestive as to the means by which disruptions to firms or managers from earnings misses could arise time. Imperfectly informed analysts, the financial media, or the distributed owners of public firms may react particularly negatively to an earnings miss and demand manager time, attention, or even litigation as they seek to gain more information about the underlying profitability prospects of the firm in question.

The results in Figures II-IV above incorporate measurement error for earnings targets within the model for the purposes of plotting model outcomes against model forecast errors. Why is this useful? Quantitative models with nonconvex costs and heterogeneity routinely yield a stark sorting of agents across a threshold (Garicano et al., 2013; Gourio and Roys, 2012) or into adjustment vs. inaction (Khan and Thomas, 2008; Berger and Vavra, 2014), and my model is no exception. In fact bunching is strong, and a range of forecast errors just below zero never occur in equilibrium if measurement error is ignored. The literature routinely incorporates some some quantitative addition, such as measurement error or maintenance investment depending on the context, in order to allow for a looser sorting of model stationary distributions. Motivated by these concerns, Theory Appendix B lays out an extended model of manager decisions with a decomposition of transitory profitability shocks to firms into two separate iid Gaussian components: $\varepsilon_{jt}$ (known to managers when policies are decided) and another component $\nu_{jt}$ (unknown to managers when policies are decided). In practice $\nu_{jt}$ serves as “target measurement error”, since the exact earnings threshold for meeting forecasts is ex-ante uncertain. However, throughout the rest of the paper in which direct comparison of firm outcomes to forecast errors is not the object of interest, I conservatively discuss results generated by the baseline model without measurement error, since the impact of earnings precision on firm earnings pressure on growth and welfare turns out to be slightly lower in this case.\(^{41}\)

\(^{41}\)The interested reader may find analogues to Figures II-IV above, without earnings target measurement error, in Numerical Appendix Figures C.V-C.VII. Also, note that for the purposes of generating Figures II-IV, I calibrate the decomposition of known and unknown transitory shock volatilities to attribute approximately half of the total estimated transitory volatility to each source.
Table V: Earnings Targets Reduce Growth, Welfare

<table>
<thead>
<tr>
<th>Quantity</th>
<th>%</th>
<th>Quantity</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>$g^\xi$</td>
<td>2.25</td>
<td>$\Delta W$</td>
<td>0.44</td>
</tr>
<tr>
<td>$g^\xi=0$</td>
<td>2.31</td>
<td>$\Delta W^{\text{dynamic}}$</td>
<td>1.32</td>
</tr>
<tr>
<td>$\Delta g$</td>
<td>0.06</td>
<td>$\Delta W^{\text{static}}$</td>
<td>-0.86</td>
</tr>
<tr>
<td>$\Delta \text{Firm Value}$</td>
<td>1.03</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The entries above represent the percent difference in the indicated aggregate quantity between the counterfactual No Targets ($= 0$) and estimated Baseline ($\hat{\xi}$) cases. The moments are computed from the stationary distributions of the respective economies, and comparisons are directly across balanced growth paths. $g$ is the aggregate quality and output growth rate. $\Delta W$, $\Delta W^{\text{dynamic}}$, and $\Delta W^{\text{static}}$ represent the consumption equivalent variation of No Targets relative to the Baseline economy, as well as its dynamic and static components, respectively. The change in firm value is the mean partial equilibrium percent change in firm value when $= \to = 0$ for an individual firm, averaged over the Baseline stationary distribution.

4.2 Real Economic Costs of Earnings Manipulation

Firm R&D policies intimately relate both to evidence of earnings manipulation, as in the previous subsection, but also systematically to real or economic outcomes for firms and the economy as a whole. To begin, Figure V displays the mean of R&D policy $z$ for the Baseline (Red) and No Targets (Black) economies conditional upon the value of the transitory shock $\xi$. Without earnings pressure, forward-looking R&D investment in the No Targets economy optimally ignores transitory profitability shocks and is flat as a function of $\xi$. However, by contrast, the Baseline R&D policy $z$ responds to short-term profitability, declining when profits are low in the current period.\textsuperscript{42} Responsiveness of R&D to transitory variation is the primary manifestation of short termism in this model. Even though a negative transitory profitability shock is not informative about the payoff to R&D in future, managers on average cut their long-term investment to avoid the disruption associated with missing their earnings forecast in the near term. Overall, earnings targets reduce R&D expenditures $z$ by -0.32% and increase the standard deviation or volatility of R&D expenditures by 23.1%.

More volatile R&D, induced by earnings targets and sensitivity to transitory profitability shocks in the Baseline model, damages the overall efficiency of the innovation process. Table VI reports the aggregate growth rate in the Baseline model, $g^\xi = 2.25\%$, which is around 6 basis points lower than long-term growth rates in the No Targets economy, $g^{\xi=0} = 2.31\%$. These differences are quantitatively larger than they may at first appear, since aggregate

\textsuperscript{42}In both the Baseline and No Targets economies, of course, higher values of the persistent shock $a$ induce higher levels of R&D expenditures $z$ on average.
growth changes lead to large compounded differences across economies far into the future. The driving force behind the diminished growth in an economy with earnings targets is curvature in the model link \( \Phi(z) \) between R&D expenditures and innovation. Given concavity of diminishing returns to R&D in \( \Phi(z) \), randomly more volatile R&D causes fewer innovation arrivals on average, even ignoring level changes in R&D expenditures.\(^4\)

A negative relationship between volatility and growth, crucial to the quantitative results here, is familiar from the empirical macroeconomics literature (Ramey and Ramey, 1995; Imbs, 2007). Furthermore, Barlevy (2004) describes the manner in which at the aggregate level, higher volatility of tangible investment caused by business cycles can increase the theoretical cost of business cycles by reducing the aggregate growth rate. The same mechanism is embedded at the microeconomic level in my Baseline model. Since macroeconomists routinely infer much higher volatility or variation in profitability at the disaggregated level than on aggregate (Bloom et al., 2012), the firm-level link between profit shocks and R&D at work here naturally provides a potent source of changes in the innovative efficiency of the economy as a whole.

To gain a better sense of the quantitative magnitude of the distortion to aggregate growth rates, I also engage in an accounting exercise for aggregate welfare. The second column of Table V displays the consumption equivalent welfare gain to the aggregate household from the removal of earnings targets, \( \Delta W \). This welfare gain is the percentage increase in consumption in each period (around 0.44%) which would make the Baseline household indifferent to the No Targets consumption stream, comparing directly across balanced growth paths. Explicit welfare change formulas and a set of quantitative robustness checks are deferred to Theory Appendix B and Numerical Appendix C, respectively.\(^4\) Based on straightforward algebra the overall gains decompose into static versus dynamic components: \( \Delta W^{\text{static}} \) is negative, representing an around 0.9% static or first-period consumption loss due to higher R&D investment in the No Targets economy. However, the compounded effect of higher growth rates more than compensates in the long-term, with dynamic gains \( \Delta W^{\text{dynamic}} \) to consumption of around 1.3% counterbalancing the higher initial investment.\(^4\)

\(^{4}\)This statement is a straightforward implication of Jensen’s inequality together with the concavity of the innovation arrival function \( \Phi(z) = Az^\alpha \), where \( \alpha \in (0; 1) \).

\(^{4}\)Recall that to remain conservative I assume that the entirety of the term in the manager payoff is apportioned to personal costs for the manager, implying that these costs should be rebated back to the household in aggregate consumption. If the effect of the mise costs is included as entirely due to firm resource costs or disruptions "miss", overall household gains are 0.48% instead.

\(^{4}\)The change in growth rates due to the removal of earnings targets is around 0.1% in the version of the
Overall, consumption equivalent gains on the order of 0.44% are large. For perspective, recent quantitative estimates of the welfare costs of business cycles range from 0.1-1.8% (Krusell et al., 2009), while the static gains from trade range from 2.0-2.5% (Costinot and Rodríguez-Clare, 2015; Melitz and Redding, 2013). I conclude from the sizable changes in growth and welfare here that the dynamic distortion to long-term R&D investment induced at firms by the presence of earnings target pressure matters for the macroeconomy.

A final quantitative perspective on earnings manipulation comes from the firm level and relates directly to a quantitative literature in corporate finance. In the Baseline economy, the change in average firm value which would result from the removal of pressure to meet earnings forecasts, also recorded in Table V, is around 1%\(^4\). For perspective on the size of this firm-level distortion we can turn to other work in structural dynamic corporate finance that quantifies the loss in shareholder value from CEO turnover frictions at around 3% (Taylor, 2010), or from manager agency frictions affecting cash holding at around 6% (Nikolov and Whited, 2013).\(^5\)

The distortions to manager long-term investment policies, and the resulting losses in firm value, growth rates, and welfare laid out above represent a quantification of the costs of pressure to meeting earnings targets. Given their quantitatively significant size, an accounting within models for earnings pressure seems important for understanding the overall process of growth in the macroeconomy. However, earnings targets may provide a range of benefits as well. In principle the benefits could be external to the firm, functioning for example through more precise valuations of companies on the equity market and more socially efficient allocations of capital across firms. Or, by contrast, earnings pressure could yield benefits for firms themselves if agency considerations drive a wedge between the interests of managers and firm owners which is alleviated by earnings discipline.

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\(^4\) This 1% figure is derived from computing average firm value from optimal policies in an environment with \(\theta = 0\), or no manager cost from missing earnings targets, with the aggregate growth rates, interest rates, and forecasting in the Baseline economy held fixed. The average is taken with respect to the equilibrium stationary distribution of state variables in the Baseline model. For conservatism I assume such costs are private to the manager. If disruption costs are borne as resource costs to the firm, the change in firm value is 1.3%.

\(^5\) This model with calibrated target measurement error for firms, with a total change in aggregate welfare of 1.39%. The increase in the effects of targets is due to the increased mass of managers who perceive a possibility of missing an earnings target, given the addition of uncertainty surrounding the target itself. Overall, the dynamic distortion to long-term investment in strengthened, and the Baseline results in the main text should therefore be considered conservative.

A detailed explanation of this measure is deferred to Theory Appendix B. Note that the change in average shareholder value is larger than the aggregate welfare change because it does not take into account the change in discounting that occurs in general equilibrium comparisons.
Consideration of such benefits from earnings targets seems important for two reasons. First, and crucially, the gains from removal of earnings pressure embodied in the No Targets counterfactual considered so far could fail to materialize in practice if policymakers were to take action preventing earnings targets and simultaneously extinguish the benefits from earnings pressure. Second, a significant portion of earnings targets could represent explicit or implicit compensation contracts with some portion of overall pay for managers dependent upon meetings earnings forecasts. In this case, a countervailing benefit from earnings targets for firms might in principle provide a microfoundation for the existence of pressure on managers to meet short-term benchmarks, even if such benchmarks lead to a loss in investment efficiency. In the next section, building off of the baseline model structure but including two potential sources of agency frictions in the firm-manager relationship, I show that for certain parametrizations earnings pressure may lead, overall, to increased firm value and social welfare.

5 Agency Benefits from Earnings Targets

Empirically, as shown in Section 2, CEOs of large US public firms which just fail to meet an earnings target or forecast are disproportionately likely to receive lower total compensation and to depart their firms. These results open up a suggestive possibility: pressure to meet earnings forecasts or targets may arise from the efforts of the boards or distributed shareholders of firms to exert discipline on the managers of firms. Within corporate finance, there is a long history of analyzing corporate investment policies in the context of agency frictions which drive a wedge between the interests of managers and the interests of firms as a whole (Stein, 2003). In this section, I consider two separate forms of agency frictions which may serve to both microfound and to provide countervailing benefits from the distortions to long-term investment induced by earnings targets.

5.1 Manager Shirking and Effort Provision

The first agency friction I consider is the possibility of shirking by managers. In particular, firm owners may be unable to observe whether managers continually exert effort, and compensation contracts can serve as a tool to mitigate the possibility of low effort provision (Edmans et al., 2009). In this framework, managers can in each period choose either to shirk ($s_{jt} = 1$) or to exert normal effort ($s_{jt} = 0$). If managers shirk, then they receive
some private benefit governed by the parameter \( \lambda_s \geq 0 \). Such shirking comes at the cost of firm variable profits, with a proportional disruption to firm quality equal to some fraction \( \gamma_s \in (0, 1) \). The remainder of the economic environment is similar to before, where manager problems can be shown to solve

\[
\max_{f_{jt}, m_{jt}, \pi_{jt}, n_{jt} \in \mathbb{R}} \mathbb{E}_{t=0}^{\infty} \left( \frac{1}{R} D_{jt}^M \right).
\]

Manager payoffs are given by \( D_{jt}^M \) where

\[
D_{jt}^M = \theta_d D_{jt} - (1 - \theta_d) \xi^{pay} | (\Pi_{jt}^{Street} < \Pi_{jt}^f) Q_{jt} + \lambda_s s_{jt} Q_{jt},
\]

and manager flow returns reflect two components. First, an exogenous compensation contract with a fixed dividend share \( \theta_d \in (0, 1) \) and a clawback by the firm of \( \xi^{pay} | (\Pi_{jt}^{Street} < \Pi_{jt}^f) Q_{jt} \) conditional upon missing an earnings target.\(^{48}\) Endogenization of such a contract is beyond the scope of the paper, but I will demonstrate in a quantitative exploration of the extended framework that earnings-target conditional compensation can be value-improving for firms on average. The second component of manager flow returns is the private benefit \( \lambda_s s_{jt} Q_{jt} \) accruing to the manager when shirking. In practice shirking benefits might represent anything from increased leisure at the firm’s expense to some sort of resource diversion from the firm to the manager. The countervailing costs of shirking for the firm enter the expression for dividends, written here net of manager clawback compensation:

\[
D_{jt} = \Pi_v(Q_{jt}, a_{jt}, e_{jt}, p_{jt})(1 - \gamma_s s_{jt}) - z_{jt} Q_{jt} - \gamma_m m_{jt} Q_{jt}.
\]

At this point it is worth exploring the tradeoffs involved for managers considering shirking. In the absence of earnings targets managers weigh a private gain from low effort equal to \( \lambda_s Q_{jt} \) versus a firm-wide loss diluted through their equity share of \( \theta_d \Pi_{jt} \gamma_s \). However, by conditioning compensation on meeting a publicly available earnings forecast, the owners of the firm can augment the immediate costs of shirking by the net amount \( (1 - \theta_d) \xi^{pay} | (\Pi_{jt}^{Street} < \Pi_{jt}^f) Q_{jt} \). For those firm-years in which shirking would lead to an earnings miss, i.e. in which earnings prospects are “near” earnings targets ex-ante, the prospect of lost compensation can induce effort provision by managers. Therefore, in an environment with manager moral hazard through effort provision, the owners of firms face a fundamental tradeoff between

\(^{48}\)By interpreting the miss costs for managers as embedded within compensation I am implicitly attributing the entirety of the estimated \( ^{pay} \) term from before to the \( ^{pay} \) term.
the dynamic distortion to long-term R&D investments from earnings pressure and the level gains which may accrue to the firm from disciplining managers and inducing less shirking on average.

To investigate more rigorously the tradeoffs involved for firms, as well as the corresponding social consequences for the aggregate household, I perform the following experiment. First, I fix the level of $\theta_d = 5.1\%$, following evidence on CEO ownership shares summarized in Nikolov and Whited (2010). Then, I fix $\xi^{\text{pay}}$ so that managers perceive a cost to missing equivalent in magnitude to the estimated miss costs $\xi$ from the structural estimation exercise above. Finally, I vary the strength of the private motive for shirking $\lambda_s$.

Figure VI plots four quantities within the model: the baseline mean prevalence of shirking in an economy with earnings targets (top left), the average increase in shirking if manager target compensation were to be removed (i.e. $\xi^{\text{pay}} \to 0$, top right), the average partial equilibrium change in firm value from target removal (bottom left), and the general equilibrium consumption equivalent change in welfare for the representative household from target removal (bottom right). Throughout this exercise, I fix the proportional loss to variable earnings at the firm from shirking at the round figure of $\gamma_s = 7.5\%$, and the horizontal axis represents the average ratio between the private returns perceived by managers and the average loss from shirking for a given value of $\lambda_s$. As the shirking motive grows, managers unsurprisingly shirk more on average. However, there is a hump-shaped pattern to the increase in shirking seen if earnings discipline were to be removed. For very low levels of shirking motive, managers already provide effort almost always, so the presence of pressure only prevents a small increase in shirking. By contrast, for intermediate levels of private value to shirking, managers are close to indifferent between shirking or not, and the presence of earnings pressure can shift a relatively larger portion of managers to provide effort. Finally, if managers have very high private returns to shirking, the lost compensation for managers does not dissuade shirking much at all relative to an environment without earnings targets. The hump-shaped pattern to the prevention of shirking feeds into counterfactual changes in firm value and social welfare: for intermediate levels of private shirking benefits, firm value would decrease on average if a firm removed miss costs for managers even though a dynamic investment distortion remains. The reduction in quality levels and hence production induced by shirking if earnings pressure were to be removed also leads to a static loss for

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49Further details behind these calculations may be found in Theory Appendix B. Also, as a robustness check, Appendix Figure C.IV plots the analogous results associated with an alternative smaller value of $\gamma_s$. 

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the aggregate household, which crucially implies that the presence of earnings targets can be welfare-enhancing if they prevent a substantial amount of costly shirking by managers.

The patterns in Figure VI suggest that discontinuous and short-term incentives for managers may play a useful disciplinary role. Firms as well as the economy as a whole can benefit from imposing earnings miss costs if managers subsequently shirk less overall, even while targets distort the R&D decisions of firms. A disciplinary role may therefore provide a rationale for the existence of earnings targets within firms, since the use of a readily observable performance benchmark can improve firm value on average. Importantly, however, the evidence presented in this section should be interpreted solely as suggestive. The next section, which considers an alternative agency justification for earnings targets, demonstrates that the exact nature of the conflict between managers and firms matters for the relationship between the firm and social returns to earnings benchmarks.

5.2 Manager Empire Building

If managers experience some private benefit from the size or scale of the firm under their control, then overinvestment or empire building may occur. This type of empire building mechanism plays a role in a range of recent quantitative corporate finance studies (Nikolov and Whited, 2010; Glover and Levine, 2014). If the owners of the firm do not perfectly observe the ex-ante expected profitability of R&D investments, then such overinvestment may be difficult to curtail in practice. However, earnings targets provide a convenient and readily observable benchmark against which manager decisions may be measured. This subsection builds a structure in which manager decisions are influenced by empire building but again can be shown to solve

$$
\max_{\Pi_{j1}, \Pi'_{j1}, \Pi''_{j1}} \mathbb{E} \left( \sum_{t=0}^{\infty} \frac{1}{R} D_{jt}^M \right)
$$

By contrast with the previous subsection, managers are not motivated by a shirking possibility, but instead face personal returns given by

$$
D_{jt}^M = \theta_d D_{jt} - (1 - \theta_d) \xi^{pay} (\Pi_{jt}^{street} < \Pi_{jt}^I)Q_{jt} + \lambda_e Q_{jt}.
$$

Again, there remains a fixed equity share $\theta_d \in (0, 1)$ of firm dividends, as well as the potential for compensation contracts imposing an earnings miss cost on managers through $\xi^{pay} > 0$. However, the final term $\lambda_e Q_{jt}$ indexes the strength of the empire-building motive for
managers, where higher values of $\lambda_c \geq 0$ imply managers with a more potent intrinsic taste for firm scale as determined by long-term quality $Q_{jt}$. Here, dividends are standard and can be written net of manager clawback compensation as

$$D_{jt} = \Pi_e(Q_{jt}, a_{jt}, \varepsilon_{jt}, p_{jt}) - z_{jt}Q_{jt} - \gamma_m^2 m_{jt}Q_{jt}.$$  

Exactly as in the analysis of manager shirking behavior above, I broadly explore the potential impact of earnings targets in the presence of empire building by first fixing $\xi^{pay}$ to duplicate the magnitude of the earnings miss costs $\xi$. Subsequently varying the strength $\lambda_e$ of the empire motive yields the four panels of results in Figure VII, each of which plots against a horizontal axis equal to the average ratio between the manager’s private return to size and their return to additional variable profits. The top left panel plots the average R&D to sales ratio for the economy with earnings targets through manager compensation. As the private return to empire building grows, the R&D to sales ratio unsurprisingly increases. The top right panel plots the increase in the R&D to sales ratio which would be observed in an economy with target removal (i.e. $\xi^{pay} \rightarrow 0$). As overinvestment from the firm perspective becomes more severe, the scope for earnings targets to provide discipline on the long-term investments of managers grows as well. Recall that by imposing miss costs through manager compensation, firms induce a distortion to R&D investment through excess sensitivity to short-term or transitory profitability shocks. For relatively weak agency conflicts (low empire motives) in fact, the bottom left panel reveals that firms would in fact gain overall in partial equilibrium from the removal of targets, since they would remove the inefficiency associated with induced short termism. However, for higher empire building pressures at firms the tradeoff shifts in favor of targets, and firms would lose value on average from their removal because of the resulting increase in overinvestment by managers.

Interestingly, the bottom right panel of Figure VII reveals that for all of the agency conflict parametrizations considered here, the aggregate household unambiguously experiences higher welfare if earnings targets are removed. To understand this result, note that intermediate goods firms realize profits and producer surplus from sales to a final goods sector, but the consumer surplus accruing to the final goods sector and eventually to the aggregate household are ignored by firm value maximization. In general this “surplus appropriability problem,” as coined by Jones and Williams (2000), causes firms to undervalue innovation and R&D investments relative to their social value to the household and leads to inefficiently
low growth rates in equilibrium.\textsuperscript{50} Therefore, as shown in Figure VII the presence of earnings targets discipline may increase intermediate goods firm value if they induce lower R&D on average, but that simultaneously discipline may lead to a social loss.

Just as in the analysis of manager shirking, the potential benefits of earnings targets in the presence of empire building recorded here should be taken as only suggestive. The quantitative strength of the surplus appropriability problem and hence the divergence between firm and social returns to R&D depends on a markup structure which, while convenient, links to the inverse capital share, and other potentially important factors such as the interplay between firm valuations, financial frictions, and earnings forecasts are omitted from the current structure. Therefore, I view a precise quantification of the benefits to firms or society from earnings targets as beyond the scope of the paper, preferring to instead simply outline that such benefits do exist and instead make quantitative statements only on the costs imposed by short-term earnings benchmarks on long-term investment efficiency.

6 Conclusion

Empirically, earnings realizations bunch directly above analyst forecasts. Firms that just meet or beat analyst targets of earnings display discontinuously lower long-term investment growth, while CEOs just failing to meet benchmarks experience lower compensation and face turnover at higher rates. Together, these results suggest a pervasive tradeoff in the data between the short-term prospects of firms and managers on the one hand versus the long-term investments and prospects of large public firms on the other.

This paper builds and estimates a quantitative endogenous growth model with R&D investment by managers subject to idiosyncratic profitability shocks and incentives to meet or beat earnings targets. Discontinuities in earnings forecast error distributions and R&D growth naturally arise, and a counterfactual exercise comparing the baseline model to an economy without earnings pressure on firms reveals that managers choose lower and more volatile R&D when short-term targets exist. Such short termism, manifested in sensitivity of R&D to purely transitory variation in profitability, leads to quantitatively significant costs for firm value, aggregate growth rates, and household welfare. The estimation of such costs is the primary quantitative contribution of the paper.

\textsuperscript{50}The technical assumption of eventual diffusion of average firm quality to lagging firms, which is not internalized by firm R&D decisions, also leads to a distinct inefficiency in this model. The surplus appropriability mechanism, however, does not rely on the diffusion mechanism.
Although earnings targets distort long-term investments at firms and impose costs of firms and the broader economy, the presence of discipline may provide benefits if managers are motivated by agency considerations such as a desire to shirk or to empire build. These benefits help to motivate the existence of earnings benchmarks for managers. In particular, for some parametrizations of such agency conflicts, a compensation contract which conditions manager pay upon meeting observable earnings forecasts leads to higher firm value on average. The final impact on social welfare from the existence of earnings benchmarks in manager compensation depends upon the exact nature of the agency conflict studied but may also be positive overall.
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Figure I: There is a Discontinuity in the Earnings Distribution

Note: Earnings forecast error is Street earnings minus median analyst forecast from a 2-quarter horizon, scaled by rm assets and expressed as a percentage. The histogram represents a panel of 32,554 rm scal years, covering 1982-2010 for 4,388 rms. 70% of sample lies within the bounds plotted above, and 7.1% have forecast error in the middle bin. 44% of the middle bin observations have exactly zero forecast error. Bin size is 0.05% of rm assets. Earnings distribution is statistically bunched at 0 at the 1% level according to the Chetty, et al. (2011) bootstrap test statistic.
Figure II: Estimated Forecast Error Distribution

Note: The figure above represents the distribution of forecast errors computed from the stationary distribution of the balanced growth path associated with both the estimated earnings miss cost (in red) and the counterfactual \( \ell = 0 \) (in black). The model is a calibrated version of the Baseline including ex-ante measurement error of targets on the part of firms. The model was solved via discretization, policy iteration, and nonstochastic simulation.
Figure III: R&D Growth versus Forecast Errors

Note: The figure plots the average R&D growth in the estimated benchmark model with miss cost $^{^\wedge}$ (in red) and no miss costs (in black) conditional upon bins of the forecast error $^f$, computed from the stationary distribution of the balanced growth path. The model is a calibrated version of the Baseline including ex-ante measurement error of targets on the part of firms. The model was solved via discretization, policy iteration, and nonstochastic simulation.
Figure IV: Profitability Sorting into Earnings Misses

Note: The figure plots the average R&D growth in the estimated benchmark model with miss (in red) and no miss costs (in black) conditional upon bins of the forecast error $\bar{f}$, computed from the stationary distribution of the balanced growth path. The model is a calibrated version of the Baseline including ex-ante measurement error of targets on the part of firms. The model was solved via discretization, policy iteration, and nonstochastic simulation. The difference in mean probability from missing is 146% in the estimated baseline, compared to 11% for $\bar{f} = 0$. 
Figure V: R&D Reacts to Short-Term Shocks

Note: The figure plots the mean R&D policy $z$ in the counterfactual No Targets (in black, with $\epsilon = 0$) and Baseline estimated model (in red, with $\epsilon$) conditional upon the value of the transitory productivity shock $\epsilon$, computed from the stationary distribution of the balanced growth path. For readability, the constant level of mean R&D $z$ in the No Targets model is normalized to 100. The model was solved via discretization, policy iteration, and nonstochastic simulation.
Figure VI: A Levels-Growth Tradeoff with Shirking

Note: Horizontal axis is $r(s)$ from $E_{s}q = rE_{d}v_{s}$, where $s = 0.075$. The top left panel plots the average shirking level $100E_{s}$ with earnings targets, the top right panel plots the percent difference in shirking from target removal, the bottom left panel plots the average PE percent change in firm value from target removal, and the bottom right panel plots the GE total consumption equivalent percent change in social welfare target removal. Numerical comparative statics have been smoothed using a second-degree polynomial.
Figure VII: Targets can Restrain Empire Building

Note: Horizontal axis is $r(\phi)$ from $E_{eq} = rE_{dv}$. The top left panel plots the average R&D to sales ratio with earnings targets, the top right panel plots the percent difference in the R&D to sales ratio from target removal, the bottom left panel plots the average PE percent change in firm value from target removal, and the bottom right panel plots the GE total consumption equivalent percent change in social welfare target removal. Numerical comparative statics have been smoothed using a second-degree polynomial.
A Data

I combine data from two main sources: 1) the Compustat database for accounting reports from publicly listed US firms, 2) the Institutional Brokers Estimate System or I/B/E/S database for analyst earnings forecasts and reported earnings for publicly listed US companies. Unless otherwise specified, data is at the firm-year level. Linking table data from the Center for Research in Securities Prices (CRSP) database is also required to connect the I/B/E/S and Compustat datasets. I also make use of the Execucomp database, complementary to Compustat, for executive compensation and turnover data.

A.1 Compustat Data

I downloaded Compustat accounting data from the US Fundamentals Annual file in the CRSP/Compustat Merged database available through Wharton Research Data Services (WRDS) in January 2014. Allowed linking codes between CRSP and Compustat were \LU" and \LC," and the following sample restrictions were made:

- Nonmissing total assets at, SIC code sic, book value of capital ppent, GAAP earnings ib, operating earnings before depreciation EBITDA oibdp, total sales sale, value of equity ceq, employment emp

Positive levels of assets and book value of capital: at, ppent > 0

No utilities or financial rms as classified by SIC code; sic not in 6000's or 4900's

Fiscal year between 1974 and 2013, from datadate year

No major mergers ag: compst not equal to \AB"

Only include primary issue securities: priusa equal to liid

A.2 I/B/E/S Data

I downloaded I/B/E/S earnings forecast and realized earnings data from WRDS in January 2014. My data construction requires les for (stock-split) adjusted detail history, unadjusted detail history, adjusted detail actuals, unadjusted detail actuals, currency headers, and identification headers. All available data as of January 2014 was used. Although sample range within each le varies, covered dates range from 1970 to 2013. The following sample restrictions were made, where applicable:

- Nonmissing I/B/E/S permanent ticker ticker, earnings per share (EPS) value of forecast or realization value, nonmissing fiscal period end date pends or fpedats, nonmissing announcement date anndats, nonmissing analyst and estimator codes analys, estimator

Only US rms, as indicated in all les by usfirm = 1
Only firms reporting in US dollars, with available primary/diluted reporting basis and historical CUSIP number, as indicated by the currency and identification header les by curr, pdi, cusip

I/B/E/S makes available forecasts for earnings per share as well as realized "Street" earnings per share on two reporting bases: \( \text{\textit{adjusted}} \)\text{"}, in which the entire time series for a security is continuously adjusted for both stock splits and primary/primary dilution factors, as well as \( \text{\textit{unadjusted}} \),\text{"} in which the originally reported forecasts and actuals are stored. Information is also available as \( \text{\textit{summary}} \) or \( \text{\textit{detail}} \)\text{"} data, with summary les containing consensus forecasts for a firm as well as reported actuals, rounded to 2 digits (i.e. cents of earnings per share) and detail les containing the history of analyst forecast rounded to 4 digits.

As Payne and Thomas (2003) note, the joint presence of stock splits and rounding in the adjusted summary les can lead to a severe loss of information as some earnings hits or misses are misclassified as zeros due to the ex-post adjustments made by I/B/E/S. Because accurate classification of earnings hits or misses is crucial to my research agenda, I must base my analysis on the unadjusted detail les. However, this requires that all analyst forecasts from the unadjusted les be readjusted to the reporting basis as of the earnings announcement date, since reporting conventions for some securities may change in between a given analyst forecast and the earnings announcement.

To readjust analyst forecasts to the same basis as announced unadjusted actuals requires the following process:

1. Merge the adjusted detail history les with the unadjusted detail history les, on I/B/E/S variables ticker, fpedats, analldats, analyzer

2. For each unadjusted forecast \( \text{\textit{unadj}} \) of EPS for ticker \( j \) in calendar year \( t \), \( \text{\textit{unadj}} \) as well as equivalent adjusted forecast \( \text{\textit{adj}} \), compute the stock split ratio of forecast \( i \) relative to the data download date \( \text{\textit{today}} \)

\[
\text{ratio}_{ijt}^{\text{\textit{today}}} = \frac{\text{\textit{unadj}}}{\text{\textit{adj}}}
\]

3. For each unadjusted actual value of EPS for ticker \( j \) in calendar year \( t \), \( \text{\textit{unadj}} \), as well as equivalent adjusted actual \( \text{\textit{adj}} \), compute the stock split ratio of the realized earnings relative in \( t \) to the data download date \( \text{\textit{today}} \)

\[
\text{ratio}_{jt}^{\text{\textit{today}}} = \frac{\text{\textit{unadj}}}{\text{\textit{adj}}}
\]

4. Based on the two ratios above, compute for each unadjusted forecast \( i \) of EPS for ticker \( j \) in calendar year \( t \), the EPS forecast \( \text{\textit{adj}} \) on the same reporting basis as \( \text{\textit{adj}} \)

\[
\text{\textit{adj}}_{ijt} = \text{\textit{unadj}}_{ijt} \times \frac{\text{\textit{today}}}{\text{\textit{today}}}
\]

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Since they are on the same reporting basis, the analyst forecasts $\text{EPS}_{ijt}$, which have 4
digit precision can be directly compared to the unadjusted actuals series $\text{EPS}^{\text{unadj}}_{jt}$, and all
forecast statistics are computed from these underlying series.

Note that forecasts are made throughout the scalar year for a given end of year financial
release. Therefore, I must make a choice of horizon at which to compute earnings forecasts.
In the baseline analysis, I consider forecasts made from a two-quarter horizon, i.e. from 91
to 180 days before the data release. Given a horizon, I construct, for a given rm and scalar
year combination ($\text{ticker}$ and $\text{pends}$ in I/B/E/S), a dataset with realized Street actuals as
well as median and mean analyst forecasts of earnings per share within that horizon window
$[d_1; d_2]$. More precisely, my forecast for a particular rm- scalar year of earnings per share
with horizon window $[d_1; d_2]$ is equal to either

$$\text{EPS}^{f}_{jt} = \text{median}_f \{ \text{EPS}_{ijt} \} \ s 2 \ [d_1; d_2] \text{ or } \text{mean}_f \{ \text{EPS}_{ijt} \} \ s 2 \ [d_1; d_2];$$
depending on the choice of aggregation technique.

A.3 Linking Compustat and I/B/E/S

Linking the Compustat and I/B/E/S data requires all observations from the underlying
Compustat data, which are uniquely identified by a combination of permanent security
identifier $\text{gvkey}$ and $\text{datadate}$, with I/B/E/S observations of realized EPS and forecast
EPS, which are uniquely identified by the permanent ticker $\text{ticker}$ and forecast period
end date variables $\text{pends}$ and $\text{fpedats}$. Following the WRDS recommendation for linking in
Moussawi (2006), these sets of identifiers can be linked through the CRSP dataset as follows.

Download the CRSP linking information with the permanent CRSP identifier $\text{permno}$
together with historical CUSIP security identifiers $\text{cusip}$ and first date of use $\text{date}$

For each observation in the Compustat dataset which, as a member of the Compus-
tat/CRSP merged database already contains the CRSP identifying PERMNO value,
use the date range in the CRSP linking table to assign an historical CUSIP value.

Match a Compustat accounting observation to an I/B/E/S forecast information and
realized earnings observation if they have identical CUSIP, PERMNO, as well as scalar
year end date (defined by year and month)

A.4 Execucomp Data

Data from the Execucomp from rm scalar years 1992-2012 database is integrated with the
Compustat panel using the common rm identifier $\text{gvkey}$ together with the data variable
$\text{datadate}$. Only CEO compensation and turnover data is used, with observations requiring
$\text{pceo}$ or $\text{ceoann}$ equal to CEO. Total compensation for a given scalar year is measured as
the ratio of CEO total pay $\text{tdc2}$ from Execucomp to total rm assets at from Compustat.
CEO turnover rates are a dummy variable constructed to equal to one if a rm's CEO
turns over in the current or next three scalar years, where CEOs are uniquely identified in
Execucomp by $\text{execid}$.
A.5 Computing Data Moments & Model Estimation

To compute model moments, I make the following further sample restrictions to the Compustat data:

- Fiscal year end between 1975 and 2010.
- Positive values of Compustat sales \( \text{sale} \) and selling, general, and administrative (SG&A) expenses \( \text{xsga} \).

I also deflate sales, SG&A, and research and development expenditures \( \text{xrd} \) by the value of the GDP deflator current as of December 2013.\(^{51}\) Given real values for a series \( x_t \), I then compute percentage growth rates as

\[
x_t = \frac{2^{x_{t-1}} - x_t}{x_{t-1}}; \quad x_t \neq 0 \text{ or } x_{t-1} \neq 0
\]

\[
x_t = 0; \quad x_t = x_{t-1} = 0
\]

This measure of growth rates as the difference relative to the average follows Davis and Haltiwanger (1992), and has the advantage of being bounded within \([-2, 2]\), with selection out of R&D for a particular year resulting in a bounded rather than missing growth value. Following the construction of growth rates and real series from Compustat data, I use the linking process described above to I/B/E/S to obtain a dataset with merged accounting (from Compustat) and earnings forecast (from I/B/E/S) data.

After the link, unscaled values of Street earnings \( \text{Street}_{jt} \) and forecasts \( \text{Street}_{jt}^f \) can be computed by multiplying either the primary or diluted share count as of the scalar year end date from Compustat \( \text{cshpri} \) or \( \text{cshfd} \), respectively, with choice determined by I/B/E/S dilution \( \text{pdi} \) by the unadjusted earnings per share actual value \( \text{EPS}_{jt}^{\text{unadj}} \) or forecast value \( \text{EPS}_{jt}^f \) from I/B/E/S. Once unscaled forecasts and actual Street earnings values exist, forecast error is defined as actual Street earnings minus forecast earnings:

\[
fe_{jt} = \text{Street}_{jt} - \text{Street}_{jt}^f .\(^{52}\)
\]

In my analysis of forecast errors, I focus on two alternative measures of forecast error. First, I consider forecast error normalized by firm assets \( \frac{fe_{jt}}{at_{jt}} \), which is a series used in generation of the forecast error histogram in the main text. Second, however, for correspondence with model moments (since a clearly defined notion of firm assets is lacking within my model structure) I can also consider percentage forecast error defined by

\[
f_{jt}^{\text{%}} = \frac{fe_{jt}}{\text{Street}_{jt} + \text{Street}_{jt}^f}; \quad \text{Street}_{ij} \neq 0 \text{ or } \text{Street}_{ij}^f \neq 0
\]

\[
0; \quad \text{Street}_{ij} = \text{Street}_{ij}^f \neq 0
\]

This measure of forecast error relative to the average absolute value of actual and forecasted Street earnings has several advantages. First, following the Davis and Haltiwanger (1992) growth rate measure above, \( f_{jt}^{\text{%}} \) is bounded in \([-2, 2]\), and can flexibly accommodate

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\(^{51}\) The GDP deflator is given by the series \( \text{GDPEDEF} \) in the Federal Reserve Bank of St. Louis’ online FRED database, accessed at http://research.stlouisfed.org/fred2/.

\(^{52}\) I omit the dependence of forecast errors on horizon, although as noted in the I/B/E/S data subsection, earnings per share forecasts are either defined as mean or median analyst expectations within a given horizon window before the data release date.
Table A.1: Covariance Matrix of Sales Growth, R&D Growth, Forecast Error

<table>
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<th>Sales</th>
<th>R&amp;D</th>
<th>% Forecast Error</th>
</tr>
</thead>
<tbody>
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<td>0.027788853</td>
<td>0.006756967</td>
</tr>
<tr>
<td>R&amp;D</td>
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<td>0.090999810</td>
<td>-0.001357295</td>
</tr>
<tr>
<td>% Forecast Error</td>
<td>0.006756967</td>
<td>-0.001357295</td>
<td>0.139255274</td>
</tr>
</tbody>
</table>

Note: The moments sample is as described in the text above, with 32,554 rm- scal year observations in an unbalanced panel with Davis and Haltiwanger (1992) growth rate and forecast error transformations applied to real sales, real R&D expenditures, and Street forecast error series in the merged Compustat and I/B/E/S dataset from 1982-2010.

I now turn to the overidentified GMM structural estimation of $\theta$ in the baseline model based on the vector of moments $m(X)$. Recall that the aggregate growth rate is used as a targeted moment in the estimation, together with the micro-level covariance matrix of sales growth, R&D growth, and forecast errors. The growth rate is the average annual growth rate of US per capita GDP from 1961-2010, FRED series USARGDPC computed from BLS data.

Under an assumption of independence between micro and macro data samples, the covariance matrix of the joint set of moments $m(X)$ is computed in a two-stage process. First, I compute the variance of the aggregate growth rate $g, \hat{\sigma}_g^2$, taking into account arbitrary stationary time series correlation in my sample of length $T$ using the stationary bootstrap of Politis and Romano (1994).

Second, note that the vector of micro moments can be written as a smooth function of unscaled first and second moments, say $\hat{\mu}$ of sales growth, R&D growth, and forecast errors, so that the estimated covariance matrix of the micro moments, $\hat{\Sigma}$ is immediately implied by an estimate of the covariance matrix of the raw moments, $\hat{\Sigma}$, and the Delta method. I compute $\hat{\mu}$ with asymptotics in the number of rms $N$ allowing for arbitrary clustering within rms. If each rm $j$ has $T_j$ observations in the sample and the average number of observations is $\hat{\lambda} = \frac{1}{N} \sum_{j=1}^{J} \frac{1}{T_j}$, then in particular

$$\hat{\mu} = \frac{1}{\hat{\lambda}} \sum_{t=1}^{T} \sum_{j=1}^{J} X_{jt}$$
\[ \hat{\lambda} = \frac{1}{N} \sum_{j=1}^{N} \sum_{s=1}^{X} \sum_{t=1}^{X} (x_{js} \hat{\lambda})(x_{jt} \hat{\lambda})^0 \]

where \( x_{jt} \) is the stacked vector of levels and cross-products of R&D growth, sales growth, and forecast errors for \( rm j \) in period \( t \).

Under an assumption that \( \hat{\lambda} = \frac{T}{N} \) asymptotically as \( N \to 1 \), which adjusts for relative sample sizes, together with the assumption of independence between the micro and macro samples, I can write the joint asymptotic covariance matrix of the vector \( m(X) \) of the aggregate growth rate and micro moments together as

\[ \begin{bmatrix} \hat{\lambda} & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} \lambda \end{bmatrix} \sim \mathcal{N}(0; V); \]

where \( \lambda = \begin{bmatrix} \hat{\lambda}^2 & 0 \\ 0 & \lambda \end{bmatrix} \).

Given the asymptotic distribution of the moments used in the estimation of the underlying structural parameters, the definition of \( \hat{\lambda} \) as the minimizer of the GMM objective function and standard GMM arguments yield the result that

\[ \begin{bmatrix} \hat{\lambda} \\ 0 \end{bmatrix} \sim \mathcal{N}(0; V); \]

where the covariance matrix of the estimated parameters is given by

\[ \begin{bmatrix} \hat{\lambda} \end{bmatrix} \sim \mathcal{N}(0; V); \]

Here, the weighting matrix \( W \) is chosen to equal the inverse of the in-sample estimate of the covariance of the stacked moments \( m(X) \), i.e. \( W = \hat{\lambda}^{-1} \). Because of the frequency adjustment due to \( \hat{\lambda} \), this choice of weighting matrix is similar to the efficient GMM weighting matrix but differs slightly by giving more weight to the aggregate growth rate, an economically defensible practice given the importance of the growth rate in my endogenous growth environment. Estimates of \( \hat{\lambda} \) are computed using particle swarm optimization, a robust and standard global stochastic optimization routine. Given \( \hat{\lambda} \) and \( W \) in hand, an estimate of the Jacobian \( \hat{\lambda} \) of model moments with respect to parameters is computed using straightforward numerical differentiation averaging over relative step sizes of 0.75%, 1%, and 1.25%.
B. Theory

B.1 Model Equilibrium

An equilibrium of the model consists of household consumption and savings policies $C_t, B_{t+1}, fS_{jt};g_j$, final goods firm input policies $fX_{jt};g_j, L^D_t$, intermediate goods firm manager R&D, pricing, accounting manipulation, shirking, and franchise pricing policies $fz_{jt};p_{jt};m_{jt};s_{jt};M_{jt};g_j$, intermediate goods firm manager rejection policies $fr_{jt};g_j$, analyst earnings forecasts $f_f^j;g_j$, aggregate final output $Y_t$, aggregate intermediate goods expenditures $X_t$, aggregate accounting manipulation expenditures $AC_t$, aggregate R&D expenditures $Z_t$, and lump-sum transfers $T^HH_t, T^M_t$, together with prices $R_{t+1}, fP_{jt};g_j$, and $w_t$ such that the following conditions hold.

Household Optimizes

Taking as given wages $w_t$, share prices and dividends $fP_{jt};g_j, fD_{jt};g_j$, and lump-sum transfers $T^HH_t$, the values for household consumption $C_t$, one-period risk free bond savings $B_{t+1}$, and share purchases in intermediate goods firms $S_{jt}$ maximize household utility according to the following problem

$$\max_{C_t; B_{t+1}; fS_{jt};g_j} \left\{ C_t + B_{t+1} + \sum_{j=0}^1 P_{jt} S_{jt} dj = R_t B_t + w_t L + \sum_{j=0}^1 (P_{jt} + D_{jt}) S_{jt} dj + T^HH_t \right\}$$

Final Goods Sector Optimizes

Taking as given wages $w_t$ and intermediate input prices $p_{jt}$, the competitive and constant returns to scale final goods sector labor and intermediate input demands $L^D_t, fX_{jt};g_j$ maximizes profits according to the following problem

$$\max_{fX_{jt};g_j,L^D_t} \left\{ Y_t = \sum_{j=0}^1 (Q_{jt}(a_{jt} + "_{jt})(1 - s_{jt})) X_{jt} dj \right\}$$

Managers Optimize

Taking as given an exogenous endowment of consumption goods $C^M_t Q_t$, exogenous persistent and transitory probability shocks $a_{jt}, "_{jt}$, long-term quality level $Q_{jt}$, previous manager R&D and paper manipulation choices $z_{jt}, m_{jt}$, next-period earnings forecasts $f_f^j$, and the previous manager's take-it-or-leave-it price $M_{jt}$ for the managerial franchise, each manager $j \in [0;1]$ born in period $t-1$ must make the end of period $t-1$ choice $r_{jt} \in \{0, 1\}$, to reject ($r_{jt} = 1$) or accept ($r_{jt} = 0$) the offer of the managerial franchise when seeking to maximize period $t$ expected utility, i.e.

$$r_{jt} = \arg\max_r \left( R_t M_{jt}(1 - r) + C^M_t Q_t + T^M_t + (1 - r)E_{t+1} \right) \left( \frac{Q_{jt}}{Q_{jt} - I_{jt}} \right)$$

Conditional upon accepting the previous manager's offer ($r_{jt} = 0$), in their
second period of life in period \( t \) each manager \( j \) born in period \( t-1 \) must make R&D investment, paper manipulation, monopoly pricing, and managerial franchising pricing over choices \( z_{jt}, m_{jt}, p_{jt}, \) and \( M_{jt} \). These decisions take as given the realization of exogenous persistent and transitory pro tability shock \( a_{jt}, w_{jt}, \) long-term quality \( Q_{jt} \), current pro t forecast \( f_{jt} \), as well as the optimal choice \( r_{jt} \) of acceptance or rejection of the managerial franchise by the next-period manager born in period \( t \). The manager seeks to maximize their period \( t \) utility, i.e. they solve the problem

\[
\max_{z_{jt}; m_{jt}; p_{jt}; s_{jt}; M_{jt}} \left( R_t M_{jt-1} + C^M Q_t + T^M + s_{Q_t} + s_{s_{jt} Q_t} + M_{jt}(1 - r_{jt}) \right)
\]

From the perspective of the manager, perceived miss costs are a combination of manager + firm + (1 - \( d \)) pay, and dividends net of manager clawback compensation and rm-borne miss costs are \( D_{jt} = (1 - c)(v(Q_{jt}; a_{jt}; w_{jt}; p_{jt})(1 - s_{s_{jt}}) z_{jt} Q_{jt}) + \text{AC}_{m_{jt}}(m_{jt})Q_{jt} \).

### Intermediate Goods Firm Values

Given exogenous persistent and transitory pro tability shocks \( a_{jt}, w_{jt}, \) long-term quality level \( Q_{jt} \), and analyst forecasts \( f_{jt} \), as well as manager-det ermined intermediate goods rm R&D investments \( z_{jt} \), monopoly prices \( p_{jt} \), shirking decisions \( s_{jt} \), and accounting manipulation choices \( m_{jt} \), the value of intermediate goods rms \( j \) at time \( t \) is given by the present-discounted value of rm dividends

\[
\sum_{t=0}^{\infty} \frac{1}{R} \text{AC}_{m_{jt}}(m_{jt})Q_{jt}^t (1 - c)(v(Q_{jt}; a_{jt}; w_{jt}; p_{jt})(1 - s_{s_{jt}}) z_{jt} Q_{jt}) + m_{jt} Q_{jt}
\]

\( Q_{jt+1} = \frac{Q_{jt}}{\max(Q_{jt}; Q_{jt+1})} \) with probability \( z_{jt} \); \( Q_{jt} \) with probability \( 1 - z_{jt} \)

\( \text{AC}_{m_{jt}}(m_{jt}) = m_{jt}^2 \)

\( a_{jt} = a(1 - a) + a a_{jt-1} + j_t; j_t N(0; \frac{2}{a}); w_{jt} N(0; \frac{2}{a}); v(Q_{jt}; a_{jt}; w_{jt}; p_{jt}) = p_{jt} X_{jt} X_{jt} \) \( X_{jt} = 1 \)

### Analyst Sector Optimizes

Taking as given normalized Street earnings last period \( j_t = \frac{\text{Street}_{j_t-1}}{Q_{jt-1}} \), an outside analyst sector forecasts normalized Street earnings \( f_{jt} \) today, where the forecast earnings levels \( f_{jt} = \frac{f_{jt-1}}{Q_{jt-1}} \) must minimize analyst loss as follows

\[ f_{jt} = \arg \min_{f_{jt}} E_{j_t-1}(f_{jt})^2 \]

### Labor and Asset Markets Clear

\[ L_t^D = L (\text{Final Goods Labor Input}) \]
\[ B_{t+1} = \sum_{j=1}^{M} (1 - r_{jt}) \delta_j \] (Borrowing for Franchise Purchases Only)

\[ S_{t} = 1 \quad \text{(Equity Share Market)} \]

\[ r_{jt} = 0 \quad \text{(Managerial Franchise Market)} \]

**Government Budget Balances**

\[ T_{t}^{HH} + T_{t}^{M} = c \left( v_{jt} (1 - s_{jt}) z_{jt} Q_{jt} \right) \delta_j \]

**Managers Consume Their Endowments**

\[ C_{t}^{M} = C_{t}^{M} \delta_j = C^{M} Q_{t} \]

**Resource Constraint and Aggregation Conditions are Satisfied**

\[ Y_{t} + C^{M} Q_{t} = C_{t} + C^{M}_{t} + X_{t} + \sum_{t} \text{Firm} + Z_{t} + AC_{t} \quad \text{(Goods Market Clearing)} \]

\[ X_{t} = Z_{t} \quad \text{(Intermediate Consumption)} \]

\[ Z_{t} = Z_{t} z_{jt} Q_{jt} \delta_j \quad \text{(R&D Investment)} \]

\[ \text{Firm}_{t} = \text{Firm}_{t} I(\text{Street}_{jt} < f_{jt}) Q_{jt} \delta_j \quad \text{(Firm Earnings Costs)} \]

\[ Z \]

\[ AC_{t} = AC_{m} (m_{jt}) Q_{jt} \delta_{j} \quad \text{(Accounting Manipulation Costs)} \]

**B.2 Normalization and Recursive Firm Problem**

Consider a stationary balanced growth path equilibrium where average quality in the economy \( q_{t} = \frac{Q_{t}}{Q_{t}} \) grows at a constant rate \( g \) and there exists an invariant distribution \((a_{jt}, s_{jt}, q_{jt}, f_{jt})\) of intermediate goods firm manager state variables with \( q_{t} = \frac{Q_{t}}{Q_{t}} \) and \( f_{jt} \) defined above. Then, immediately I have that all of the aggregates in the economy grow at the rate \( g \) as well, since

\[ X_{t} = Z_{t} X_{jt} \delta_j = Q_{t} L(a_{jt} + "jt)(1 - s_{jt})q_{jt} \delta_j / Q_{t} \]

\[ Z_{t} = Z_{t} z_{jt} Q_{jt} \delta_j = Q_{t} z_{jt} q_{jt} \delta_j / Q_{t} \]

\[ \text{Firm}_{t} = \text{Firm}_{t} I(\text{Street}_{jt} < f_{jt}) Q_{jt} \delta_j = Q_{t} \text{Firm}_{t} I(\text{Street}_{jt} < f_{jt}) q_{jt} \delta_j / Q_{t} \]

\[ Z \]

\[ AC_{t} = AC_{m} (m_{jt}) Q_{jt} \delta_{j} = Q_{t} AC_{m} (m_{jt}) q_{jt} \delta_{j} / Q_{t} \]
\[ Y_t = L^{\frac{Z}{(1 - s_{jt})}} \left[ Q_{jt}(a_{jt} + s_{jt}) \right] X_{jt} \quad d = L^{\frac{Z}{Q_t}} q_t(a_{jt} + s_{jt}) d / Q_t \]

\[ C_t = Y_t \quad X_t \quad Z_t \quad AC_t \quad \text{firm} / Q_t : \]

Therefore, the household intertemporal Euler equation for savings in one-period bonds yields the standard result of a constant interest rate \( R_{t+1} = \frac{1}{(1 + g)} = R \). Note, as will be shown below, that manager value maximization solves

\[
\max_{z_{jt}; m_{jt}; s_{jt}} E_0 \left( \sum_{t=0}^{\infty} \frac{1}{R} M_{jt}^t \right) = \max_{z_{jt}; m_{jt}; s_{jt}} E_0 \left( \sum_{t=0}^{\infty} \frac{1}{R} Q_t \frac{M_{jt}^t}{Q_t} \right)
\]

Note that the above trivially omits the monopoly pricing decision \( p_t = 1 \) from the rm problem. Also, if \( 1 + g = (1 + g)^1 < 1 \). \( D_{jt}^M \), the manager ow return written in full in the equilibrium above, is homogenous in \( Q_{jt} \) and hence stationary since \( q_{jt} = Q_{jt} / Q_t \) is stationary. Therefore, the intermediate goods rm manager's objective exists in stationary, normalized form.

Recall that an assumption above was that manager policies could be obtained as the result of maximization of manager ow returns discounted by the market interest rate. To see this, rst note that manager \( j \) born in time \( t = 1 \) will accept the offer of a managerial franchise (i.e. set \( r_{jt} = 0 \)) for the following period \( t \) at price \( M_{jt}^1 \) if and only if

\[
R_t \frac{M_{jt}^1}{Q_t} E_{jt} \quad d_{jt}^{M_{jt}^1} I\left( \text{Street} < f_{jt}^t \right) Q_{jt} \quad : \]

Via backward induction, since \( M_{jt}^1 \) is a take-it-or-leave it price from the previous manager and since the previous manager's utility is strictly increasing in \( M_{jt}^1 \), it must always be the case that market clearing for managerial franchises pins down the price \( M_{jt}^1 \);

\[
M_{jt}^1 = \frac{R_t}{E_{jt}} \quad d_{jt}^{M_{jt}^1} I\left( \text{Street} < f_{jt}^t \right) Q_{jt} \quad : \]

Repeated forward substitution into the expression for manager consumption in period \( t \) therefore implies that in period \( t \) the manager born in \( t = 1 \) maximizes the present discounted stream of manager utilities from period \( t \) onwards.

Note that because they are exogenous to the manager's linear payos, the manager consumption endowments \( C_t^M \) and transfers \( T_{jt}^M \) do not impact manager policies or intermediate goods rm values. However, both terms are useful technically. A high enough value of \( C_t^M \) ensures that potentially negative dividends and clawbacks do not result in negative manager consumption levels. Meanwhile an appropriate and maintained choice of \( T_{jt}^M = R_t d_{jt} + I\left( \text{pay} < f_{jt}^t \right) Q_{jt} \) ensures that manager consumption on aggregate is equal to exogenous endowment levels \( C_t^M \) exactly. Hence, household consumption can
be backed out via the resource constraint, i.e.

\[ C_t = Y_t - X_t - A_t - Z_t \]

which is the expression used to argue for \( R_t = R \) above.

Also, trivially note that the analyst problem yields \( j^t_t = E( j^t_t | j^t_{t-1}) \) given the mean squared error loss function for analysts. Omitting \( t \) and \( j \) subscripts for clarity, using \( 0 \) to denote future periods, and writing the rm problem recursively yields

\[
V^M(a; \alpha; q; f) = \max_{z; m; s} \quad d \quad 1( < f) q + \; s q + \; s q + \; \frac{1 + g}{R} \; EV^M(a^0; \alpha^0; q^0; f^0)
\]

\[
d = (1 - \alpha) (a + s)L(1 - s) \; zq \quad AC_m(m) q
\]

\[
a^0 = a(1 - a) + sa + \frac{1}{a} \quad N(0; \frac{1}{a}) \; \; a^0 \quad N(0; \frac{1}{a})
\]

\[
AC_m(m) = m m^2
\]

\[
q^0 = \frac{1+g}{(1+g)^2} \quad \text{max prob.} (z) = A z
\]

\[
q = q^0 \quad \text{with prob.} \; 1 \quad (z)
\]

\[
f^0 = E(0 | a; \alpha; q; f)
\]

The stationary, recursive, normalized intermediate goods rm manager problem above features discounting at rate \( 1+g \) = \( R \) rather than \( 1 = R \), and sees "depreciation" of normalized relative long-term quality levels \( q \) by the rate \( g \) each period. In this form, the problem can be solved using standard numerical dynamic programming techniques, as discussed in the Numerical Appendix C below. Also, once optimal policies are obtained, a similar recursive structure obtains for intermediate goods rm values themselves through direct substitution of manager optimal policies.

Now I explicitly define the notion of stationarity which must be satisfied by the distribution of normalized state variables \((a; \alpha; q; f)\). The distribution must be invariant to forward iteration on both the exogenous driving probability processes \( a \) and \( \alpha \) as well as the endogenous forecast and long-term quality transitions. Let \( z(a; \alpha; q; f) \), \( m(a; \alpha; q; f) \), and \( (a; \alpha; q; f) \) be the optimal R&D policy, optimal accounting manipulation policy, and induced normalized Street earnings functions, and let \( f_a(a; \alpha) \) and \( f_\alpha(\alpha) \) be the transition and density functions for the exogenous processes. Formally, the stationary distribution satisfies the following condition.

\[
R \; z(a; \alpha; q; f) \; f_a(a; \alpha) f_\alpha(\alpha) d \; q^0 = \frac{1}{1+g} \; E(0 | a; \alpha; q; f) \; d \; (a; \alpha; q; f)
\]

\[
R \; z(a; \alpha; q; f) \; f_a(a; \alpha) f_\alpha(\alpha) d \; q^0 = \frac{1}{1+g} \; E(0 | a; \alpha; q; f) \; d \; (a; \alpha; q; f)
\]

The aggregation condition which must further be satisfied on a stationary balanced growth
path, which guarantees that the aggregate growth rate of long-term quality is generated by rm policies and the stationary distribution, repeats here from the main text.

\[ 1 + g = \frac{Q_0}{Q} = \frac{R}{Q} (z(a;"; q; f)) \frac{dq}{d(a;"; q; f)} + \frac{R}{Q} q \frac{d!}{d(a;"; q; f)} \]

Given the stationary distribution, the first term represents quality growth generated by quality ladder innovation arrivals, the second term represents quality growth from lagging-quality rms away from the diffusion bound, and the final term represents quality growth from lagging quality rms at the diffusion boundary.

Note that the model used for cost estimation in Section 4 imposes \( e = s = s_j = 0 \) and \( \alpha = \) manager, i.e. the model assumes away agency conflicts and mechanical resource costs of earnings misses, while the shirking model in Section 5 assumes \( e = 0 \) and the empire building case in Section 5 assumes \( s = s_j = 0 \). Both models of Section 5 assume \( \alpha = (1 - d) \) pay, i.e. that the costs of earnings misses represent explicit manager compensation policies.

B.3 Welfare and Firm Value Change Formulas

The total consumption equivalent welfare gains from the removal of earnings targets, i.e. moving from \( > 0 \) to \( = 0 \) comparing balanced growth paths only, can be written as 100 where \( \alpha \) satisfies the following equation:

\[ \frac{X_{t=0}(C_t;\text{targets})(1 + g)}{1} = \frac{X_{t=0}}{1}(C_t;\text{notargets}) \]

All \( \text{targets} \) subscripts refer to cases with \( > 0 \) and \( \text{notargets} \) subscripts refer to cases with \( = 0 \). Trivially, this yields the following formula and decomposition of the welfare gains from removal of the earnings target friction:

\[ \frac{C_{0;\text{notargets}}}{C_{0;\text{targets}}} \frac{1}{1} \left( 1 + g_{\text{targets}} \right) \frac{1}{1} \left( 1 + g_{\text{notargets}} \right) \]

The above welfare calculations are general equilibrium, in that they take into account all aggregate changes in growth rates, forecasting systems, and the stationary distribution of the economy when targets are removed. By contrast, the partial equilibrium change in rm value resulting from the removal of earnings targets is computed leaving these quantities unchanged, since from the perspective of the rm such aggregates are fixed. The resulting formula for the average change in rm value used in the text is

\[ 100E_{\text{targets}} \log \frac{V_{\text{notargets}}}{V_{\text{targets}}} : \]

Note that the text reports in the cost estimation of Section 4 a conservative version of the
measures above which omit the direct effect of the removal of earnings targets costs on the aggregate consumption level and firm value (by assuming costs are private to the manager, \( = \text{manager} \)). Therefore, there is no mechanical effects of the target removal on aggregate consumption or firm dividends through a resource channel. Section 5, which assumes that miss costs are based on manager compensation, does not allow a mechanical impact of miss costs on aggregate consumption through the lump-sum transfers away from managers but does allow for clawback to increase firm ow dividends for valuation purposes.

B.4 Adding Measurement Error

The main text shows results for a version of the baseline model with \( target measurement error \( _t \) for firms, i.e. some transitory Gaussian white noise disturbance with variance \( \sigma^2 \) for firm \( j \) in period \( t \), which is unknown at the time manager policies are determined but shifts the realized profits for firms and hence the relevant earnings target. More precisely, this simply involves replacement of the standard intermediate goods firm manager optimization problem from the equilibrium definition above with one that incorporates \( _t \):

\[
\max_{z_{jt}; m_{jt}; \eta_t} \quad \mathbb{E} \left( \sum_{t=0}^{\infty} \left( (1-c)(\nu(Q_{jt}; a_{jt}; \eta_{jt}; p_t) Z_t Q_{jt}) + \frac{1}{R} AC_m(m_{jt})Q_{jt} \right) \right) \quad \text{subject to } \quad (j_{\text{Street}} + \beta_{jt} Q_{jt}) < \frac{f}{f_{jt}} Q_{jt}
\]

\[
Q_{jt+1} = \begin{cases} Q_{jt}; & \text{with probability } (z_{jt}) \\ \max(Q_{jt}; Q_{jt+1}); & \text{with probability } 1 - (z_{jt}) \\ (z_{jt}) = A z_{jt} 
\end{cases}
\]

\[
AC_m(m_{jt}) = m m^2
\]

\[
a_{jt} = a(1 - a) + a a_{jt-1} + \eta_{jt}; \quad \eta_{jt} \sim N(0; \frac{\sigma^2}{a}); \quad \eta_{jt} \sim N(0; \frac{\sigma^2}{\eta}); \quad \eta_{jt} \sim N(0; \frac{\sigma^2}{\eta})
\]

In practice, since isn’t a state variable for the firm at the time policies are determined, the recursive normalized problem can be modified from the statement above to the following form:

\[
V^m(a; \eta; q; f) = \max_{z,m} \left( (1-c)(a + \eta) q L z + m \right) + \frac{1}{R} \mathbb{E} V^m(a; \eta; q; f)
\]

\[
a^0 = a(1 - a) + a a + \eta^0; \quad \eta^0 \sim N(0; \frac{\sigma^2}{a}); \quad \eta^0 \sim N(0; \frac{\sigma^2}{\eta}); \quad \eta^0 \sim N(0; \frac{\sigma^2}{\eta})
\]

\[
AC_m(m) = m m^2
\]

Note that since the measurement error version is only discussed in the context of the cost estimation model with \( e = s = s = 0 \), I omit those terms from the dividend owns above and write the earnings miss costs as \( \tilde{\eta} \), which is simply equal to \( = \tilde{d} \) in previous notation.
C Numerical Solution

The aggregates of the model which are crucial for the general equilibrium solution include the
growth rate $g$ and the forecast function $f = E ( j_{1})$. First, I approximate the forecast
function with a linear rule $f = 0 + 1 \cdot 1$. The comparison of model-implied conditional
expectations and linear forecasts in Figure C.I, as well as the robustness check to a quadratic
forecast rule in Table C.II, indicate that the linear forecast approximation is reasonable.

Given the forecast rule approximation, the model is solved via a combination of dis-
cretization, policy iteration, and nonstochastic simulation, together with an outer loop over
aggregates. In other words, the rough solution algorithm, given a parametrization of the
model, consists of:

1. Guess values for the aggregate growth rate $g$, as well as forecast coefficients $0; 1$.
   (a) Solve the normalized, recursive manager Bellman equation stated in Theory Ap-
   pendix B to some specified tolerance, using discretization of the exogenous pro-
   cesses as discussed below, discretization of value and policy functions, and Howard
   policy acceleration. Within this step, the manager discounts the future using the
   growth-rate normalization as well as interest rate implied by the guess for $g$ and
   the household Euler equation, and earnings targets transition according to the
   assumed forecast coefficients on normalized reported Street earnings.
   (b) Given a solution to the firm problem, use the nonstochastic simulation approach
   of Young (2010) to iterate forward on exogenous processes and endogenous trans-
   actions until a stationary distribution is obtained to some tolerance.
   (c) Compute the implied aggregate growth rate $\bar{g}$, as well as the implied forecast
   coefficients $\bar{0}; \bar{1}$.

2. If the maximum absolute differences between the guessed and implied growth rates
   and forecast coefficients are less than some predetermined tolerances, the model is
   solved. If the outer loop has not yet converged, then update either the growth rate
   (using bisection) or the forecast coefficients (using dampened fixed-point iteration),
   until they converge to model-implied values.

Some of the practical choices for numerical implementation are listed in the table below.
The model is solved using Fortran with heavy parallelization. Note that when required,
forward iterations of endogenous variables required both for distributional iteration as well
as expectations in the manager Bellman equation use linear interpolation in the endogenous
variable.
Table C.I: Some Practical Numerical Choices

<table>
<thead>
<tr>
<th>Object</th>
<th>Value</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$n_q$</td>
<td>25</td>
<td>Density of q grid</td>
</tr>
<tr>
<td></td>
<td>[0:08,12.24]</td>
<td>Bounds of q grid</td>
</tr>
<tr>
<td>$n$</td>
<td>20</td>
<td>Density of grid</td>
</tr>
<tr>
<td></td>
<td>[-0.5,1.5]</td>
<td>Bounds of grid</td>
</tr>
<tr>
<td>$n_a$</td>
<td>7</td>
<td>Density of a grid</td>
</tr>
<tr>
<td></td>
<td>[0.59,1.41]</td>
<td>Bounds of a grid</td>
</tr>
<tr>
<td>$n^-$</td>
<td>3</td>
<td>Density of $^-$ grid</td>
</tr>
<tr>
<td></td>
<td>[-0.20,20]</td>
<td>Bounds of $^-$ grid</td>
</tr>
<tr>
<td>$n_z$</td>
<td>15</td>
<td>Density of z grid</td>
</tr>
<tr>
<td></td>
<td>[0.0,0.5]</td>
<td>Bounds of z grid</td>
</tr>
<tr>
<td>$n_m$</td>
<td>15</td>
<td>Density of m grid</td>
</tr>
<tr>
<td></td>
<td>[-0.5,0.5]</td>
<td>Bounds of m grid</td>
</tr>
<tr>
<td>$N_{\text{Howard}}$</td>
<td>250</td>
<td>Number of Howard accelerations</td>
</tr>
<tr>
<td>&quot;$\text{pol}$&quot;</td>
<td>0.0</td>
<td>Tolerance for discretized policy convergence</td>
</tr>
<tr>
<td>&quot;$\text{dist}$&quot;</td>
<td>1e-9</td>
<td>Tolerance for distributional convergence</td>
</tr>
<tr>
<td>&quot;$\text{outer_g}$&quot;</td>
<td>1e-5</td>
<td>Tolerance outer GE loop for g</td>
</tr>
<tr>
<td>&quot;$\text{outer_}}$&quot;</td>
<td>1e-2</td>
<td>Tolerance outer GE loop for</td>
</tr>
<tr>
<td>update</td>
<td>0.25</td>
<td>Dampening weight on new values for</td>
</tr>
</tbody>
</table>

Note: The table above describes some practical numerical choices made to solve the normalized recursive model described in the Theory Appendix B. The model is solved with discretization, and the grid boundaries as well as densities are displayed above, together with tolerances for the various fixed-points required by the model and described in the numerical solution overview above.
Table C.II: Robustness Checks in the Baseline Model

<table>
<thead>
<tr>
<th></th>
<th>g</th>
<th>( W_{\text{stat}} )</th>
<th>( W_{\text{dyn}} )</th>
<th>( W )</th>
<th>( E (R&amp;D) )</th>
<th>(R&amp;D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( a = 0.04 )</td>
<td>0.11</td>
<td>-1.09</td>
<td>2.51</td>
<td>1.40</td>
<td>-7.20</td>
<td>23.12</td>
</tr>
<tr>
<td>( a = 0.12 )</td>
<td>0.06</td>
<td>2.74</td>
<td>1.29</td>
<td>4.06</td>
<td>-5.11</td>
<td>11.20</td>
</tr>
<tr>
<td>( \gamma = 0.06 )</td>
<td>0.06</td>
<td>-0.71</td>
<td>1.27</td>
<td>0.55</td>
<td>-0.63</td>
<td>22.42</td>
</tr>
<tr>
<td>( \gamma = 0.14 )</td>
<td>0.06</td>
<td>-0.06</td>
<td>1.29</td>
<td>1.23</td>
<td>-3.80</td>
<td>29.31</td>
</tr>
<tr>
<td>( a = 0.85 )</td>
<td>0.06</td>
<td>-1.66</td>
<td>1.36</td>
<td>-0.33</td>
<td>-4.17</td>
<td>45.52</td>
</tr>
<tr>
<td>( a = 0.95 )</td>
<td>0.06</td>
<td>0.22</td>
<td>1.45</td>
<td>1.67</td>
<td>-3.98</td>
<td>10.41</td>
</tr>
<tr>
<td>( A = 0.21 )</td>
<td>0.05</td>
<td>-0.32</td>
<td>1.25</td>
<td>0.92</td>
<td>-2.25</td>
<td>5.57</td>
</tr>
<tr>
<td>( A = 0.275 )</td>
<td>0.06</td>
<td>-0.13</td>
<td>1.32</td>
<td>1.19</td>
<td>-3.68</td>
<td>23.05</td>
</tr>
<tr>
<td>( m = 0.25 )</td>
<td>0.05</td>
<td>-0.57</td>
<td>1.18</td>
<td>0.61</td>
<td>-3.18</td>
<td>31.37</td>
</tr>
<tr>
<td>( m = 0.35 )</td>
<td>0.07</td>
<td>-0.82</td>
<td>1.48</td>
<td>0.65</td>
<td>-0.90</td>
<td>26.13</td>
</tr>
<tr>
<td>( m = 1 )</td>
<td>0.05</td>
<td>-1.04</td>
<td>1.12</td>
<td>0.08</td>
<td>-4.50</td>
<td>54.54</td>
</tr>
<tr>
<td>( = 0.5^A )</td>
<td>0.05</td>
<td>-1.37</td>
<td>1.04</td>
<td>-0.34</td>
<td>-0.17</td>
<td>22.74</td>
</tr>
<tr>
<td>( = 2.0^A )</td>
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<td>-0.30</td>
<td>2.96</td>
<td>2.64</td>
<td>-6.53</td>
<td>44.27</td>
</tr>
<tr>
<td>( = 0.4 )</td>
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<td>1.55</td>
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</tr>
<tr>
<td>( = 0.6 )</td>
<td>0.08</td>
<td>-0.15</td>
<td>1.94</td>
<td>1.79</td>
<td>-2.07</td>
<td>25.90</td>
</tr>
<tr>
<td>( = 0.5 )</td>
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</tr>
<tr>
<td>( = 1.2 )</td>
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<td>-0.32</td>
<td>1.57</td>
<td>1.25</td>
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</tr>
<tr>
<td>Random Walk Forecast</td>
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<td>Quadratic Fcst</td>
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</tr>
<tr>
<td>Fcst Bias = 0.01</td>
<td>0.08</td>
<td>-0.80</td>
<td>1.82</td>
<td>1.01</td>
<td>-6.05</td>
<td>31.90</td>
</tr>
<tr>
<td>Fcst Bias = 0.01</td>
<td>0.06</td>
<td>-0.86</td>
<td>1.32</td>
<td>0.44</td>
<td>-0.32</td>
<td>23.06</td>
</tr>
<tr>
<td>Baseline</td>
<td>0.06</td>
<td>-0.86</td>
<td>1.32</td>
<td>0.44</td>
<td>-0.32</td>
<td>23.1</td>
</tr>
</tbody>
</table>

Note: The entries above represent percent differences between the counterfactual \( = 0 \) and estimated benchmark \( ^A \) cases. The moments are computed from the stationary distributions of the respective economies.
Figure A.I: Earnings Forecast Error Distribution is Kinked in Break Tests

Note: Earnings forecast error is Street earnings minus median analyst forecast from a 2-quarter horizon, scaled by rm assets and expressed as a percentage. The histogram represents an unbalanced panel of 32,554 rm scal years, covering 1982-2010 for 4388 rms. "Actual Distribution" represents the observed histogram of forecast errors, with bin size 0.05% of rm assets (approx. $1.1 million at mean assets). "Counterfactual" represents a counterfactual predicted histogram estimated using a polynomial model. The excess density t-test is bootstrapped following Chatty, et al. (2011). Note that the McCrary (2008) sorting test statistic for a break in the distribution of forecast errors at 0 is 1.93 (0.0362), with p-value=0.
Figure A.II: No Detected Discontinuity for Tangible Investment

Note: The horizontal axis is earnings forecast error, Street earnings minus median analyst forecasts from a 2-quarter horizon, scaled by rm assets as a percentage. The plotted lines indicate the predicted percentage intangible investment rate from local linear regressions on either side of a 0 forecast error cutpoint, together with 90% pointwise confidence intervals. Tangible investment rates are residualized from rm and year means. The sample is an unbalanced panel of 23,271 rm-years from 1983-2010 with 3,978 rms.
Figure A.III: Intangibles Growth is Lower for Firms Just Meeting Targets

Note: The horizontal axis is earnings forecast error, Street earnings minus median analyst forecasts from a 2-quarter horizon, scaled by firm assets as a percentage. The plotted lines indicate the predicted Davis & Haltiwanger (1992) percentage selling, general, and administrative expense growth from local linear regressions on either side of a 0 forecast error cutpoint, together with 90% pointwise confidence intervals. Intangibles growth rates are residualized from firm and year means. The discontinuity is -25.2% of the unconditional mean in the unbalanced panel of 23,271 firm-years from 1983-2010 with 3,978 firms.
Figure A.IV: R&D Growth is Lower for Firms Just Meeting Targets

Note: The horizontal axis is earnings forecast error, Street earnings minus median analyst forecasts from a 2-quarter horizon, scaled by rm assets as a percentage. The plotted lines indicate the predicted percentage Davis & Haltiwanger (1992) R&D growth from local linear regressions on either side of a 0 forecast error cutpoint, together with 90% pointwise confidence intervals. R&D growth rates are residualized from rm and year means. The discontinuity is -25.4% of the unconditional mean in the unbalanced panel of 23,271 rm-years from 1983-2010 with 3,978 rms.
Figure A.V: CEOs Leave Firm More Often after Missing Targets

Note: The horizontal axis is earnings forecast error, Street earnings minus median analyst forecasts from a 2-quarter horizon, scaled by firm assets as a percentage. The vertical axis is the probability, in percent, of the CEO leaving the firm in the current or next three scal years. The plotted lines indicate predictions from local linear regressions on either side of a 0 forecast error cutpoint, using a triangular kernel, together with 90% pointwise confidence intervals. The estimated discontinuity is -16.1% of the unconditional mean.
Figure A.VI: CEO Compensation is Lower when Missing Targets

Note: The horizontal axis is earnings forecast error, Street earnings minus median analyst forecasts from a 2-quarter horizon, scaled by rm assets as a percentage. The vertical axis is total CEO compensation scaled by rm assets, in percent. The plotted lines indicate predictions from local linear regressions on either side of a 0 forecast error cutpoint, using a triangular kernel, together with 90% pointwise confidence intervals. The estimated discontinuity is 6.9% of the unconditional mean.
Figure C.I: Linear Forecast Rule is a Reasonable Approximation

Note: The figure plots the linear forecast of normalized earnings $f$, together with the conditional mean of earnings $E(f | \pi_{-1})$, given lagged earnings $\pi_{-1}$, with expectations taken over the stationary distribution of the Baseline model. The model was solved via discretization, policy iteration, and nonstochastic simulation.
Figure C.II: Ergodic Distributions in the Estimated and No Targets Models

Note: The figure plots the marginal ergodic distributions of the firm-level state variables and policy variables in both the estimated benchmark model and the counterfactual model with no targets. The model was solved via discretization, policy iteration, and nonstochastic simulation.
Figure C.III: Elasticities of Model Moments with Respect to Parameters

Note: The figure plots, for each of the seven moments used in GMM estimation of the baseline model, the elasticity of the moment with respect to each of the six estimated parameters. The elasticity is computed by first regressing the realized value of each moment on all six parameters, using as data moments from the ergodic distributions of the set of model solutions from the GMM estimation optimization process. The appropriate linear OLS coefficient was converted to an elasticity using the ratio of the relevant estimated parameter and the data value of the indicated moment.
Figure C.IV: A Levels-Growth Tradeoff with Shirking

Note: Horizontal axis is \( r(s) \) from \( \frac{E_s g}{E_d v} \), where \( s = 0.025 \). The top left panel plots the average shirking level \( 100E_s \) with earnings targets, the top right panel plots the percent difference in shirking from target removal, the bottom left panel plots the average PE percent change in firm value from target removal, and the bottom right panel plots the GE total consumption equivalent percent change in social welfare target removal. Numerical comparative statics have been smoothed using a second-degree polynomial.
Forecast Error = (Actual - Forecast)/Quality

No Earnings Targets
Estimated Targets

Figure C.V: Forecast Error Distribution, No Measurement Error

Note: The figure above represents the distribution of forecast errors computed from the stationary distribution of the balanced growth path associated with both the estimated earnings miss cost (in red) and the counterfactual = 0 (in black). The model was solved via discretization, policy iteration, and nonstochastic simulation.
Figure C.VI: R&D Growth, No Measurement Error

Note: The figure plots the average R&D growth in the estimated benchmark model with miss cost \(^\wedge\) (in red) and no miss cost (in black) conditional upon bins of the forecast error \(^f\), computed from the stationary distribution of the balanced growth path. The model was solved via discretization, policy iteration, and nonstochastic simulation.
Figure C.VII: Firm Selection, No Measurement Error

Note: The figure above represents the conditional mean of profitability $a$ for firms missing their forecasts ($< \bar{f}$), and firms meeting their forecasts ($\bar{f}$), computed from the stationary distribution of the balanced growth path associated with both the estimated earnings miss cost $\hat{\mu}$ (in red) and $\mu = 0$ (in black). The difference in mean profitability from missing is 193% in the estimated baseline, compared to 25% for $\mu = 0$. 